MISSILE GEOPHYSICS DIVISION

WEATHER ELEMENTS IN THE TULAROSA BASIN

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US Army Signal Missile Support Agency

SPECIAL REPORT 40

WHITE SANDS MISSILE RANGE
NEW MEXICO

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HEADQUARTERS
U. S. ARMY SIGNAL MISSILE SUPPORT AGENCY
WHITE SANDS MISSILE RANGE
NEW MEXICO

JULY 1960

1. Special Report Nr 40 has been prepared under the supervision of the Missile Geophysics Division and is published for the information and guidance of all concerned.

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WEATHER ELEMENTS IN THE TULAROSA BASIN

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SPECIAL REPORT NR 40

JULY 1960

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ABSTRACT

THE PHYSICAL FEATURES OF THE TULAROSA BASIN AND THE LOCAL WIND EFFECTS IN THE BASIN ARE DISCUSSED. MONTHLY AND ANNUAL WIND ROSES FOR THREE WEATHER STATIONS IN THE BASIN AND A CASE HISTORY OF WIND VARIABILITY ON THE WHITE SANDS MISSILE RANGE ARE PRESENTED.

TABLES, GRAPHS, AND CHARTS SHOWING THE MEANS AND EXTREMES OF TEMPERATURE, PRECIPITATION AND OTHER WEATHER ELEMENTS ARE INCLUDED, GIVING A COMPREHENSIVE PICTURE OF WEATHER CONDITIONS WHICH MAY BE ENCOUNTERED IN THIS AREA

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INTRODUCTION

THE WEATHER CONDITIONS ENCOUNTERED ON A MISSILE RANGE HAVE A PROFOUND EFFECT ON THE EFFICIENCY AND SUCCESS OF MANY OPERATIONS. THIS REPORT SETS FORTH THE FUNDAMENTAL CAUSES OF SURFACE WIND VARIABILITY IN THE TULAROSA BASIN AND PRESENTS DATA SHOWING THE MANY VARIABLES OF WEATHER WHICH CAN OCCUR IN THIS AREA. BECAUSE OF THE GREAT EXTENT OF THE REGION AND ITS IRREGULAR TOPOGRAPHY AND SINCE THERE ARE ONLY TWO WEATHER BUREAU STATIONS WITHIN THE LIMITS OF THE MISSILE RANGE, ALL OF THE AVAILABLE U. S. WEATHER BUREAU [1] TEMPERATURE AND RAINFALL RECORDS FOR THE ADJACENT AREAS HAVE BEEN USED (TABLE I, FIG. 1). WEATHER DATA FOR THE REGULARLY-STAFFED STATIONS WITHIN THE BASIN ARE PRESENTED IN GRAPHICAL FORM. IN ADDITION, A SPATIAL VARIABILITY STUDY WAS CONDUCTED AT FOUR SITES ON THE WHITE SANDS MISSILE RANGE WITH RESULTANT DATA ILLUSTRATING THE SIGNIFICANCE OF TOPOGRAPHIC EFFECTS.

PHYSICAL FEATURES OF THE TULAROSA BASIN

THE TULAROSA BASIN LIES IN SOUTH-CENTRAL NEW MEXICO AND EXTENDS SOUTHWARD A SHORT DISTANCE INTO TEXAS, WITH A MAJOR NORTH-SOUTH AXIS (FIG. 2). THE BASIN IS APPROXIMATELY 140 MILES LONG AND 40 MILES WIDE WITH A SLIGHT UPSLOPE FROM SOUTH TO NORTH. THE FLOOR OF THE BASIN IS RELATIVELY FLAT. MOUNTAINS BOUNDING THE AREA ARE PRINCIPALLY TILTED SEDIMENTARY RANGES BUT GRANITIC UPTHRUSTS FORM THE ORGAN MOUNTAINS. TO THE WEST OF THE MISSILE RANGE THE MAJOR MOUNTAIN CHAINS ARE THE ORGAN, SAN ANDRES, AND FRANKLIN MOUNTAINS. THE EASTERN LIMITS OF THE BASIN ARE OUTLINED BY THE SACRAMENTO, SIERRA BLANCA, AND THE HUECO MOUNTAINS. THE BASIN IS BOUNDED ON THE NORTH BY THE SIERRA OSCURA MOUNTAINS. THE AVERAGE ELEVATIONS OF THE RANGES BORDERING THE AREA VARY FROM APPROXIMATELY 5,500 TO 9,000 FEET MSL, WITH SIERRA BLANCA PEAK NEAR RUIDOSO REACHING A HEIGHT OF 12,003 FEET MSL. THERE IS ONE SMALL RANGE IN THE BASIN, THE JARILLA MOUNTAINS, NEAR OROGRANDE, ABOUT 10 MILES LONG WITH A MAXIMUM ELEVATION OF 5,301 FEET MSL. THE ELEVATION OF THE BASIN FLOOR IS 3,900 FEET IN THE VICINITY OF EL PASO, AND IS GENERALLY ABOUT 4,000 FEET MSL FROM THE WHITE SANDS BLOCKHOUSE AREAS NORTHWARD TO THE FOOTHILLS OF THE SIERRA OSCURA MOUNTAINS. THE LOWEST ELEVATION IS 3,887 FEET MSL AT LAKE LUCERO (FIG. 3).

ABOUT THREE-FOURTHS OF THE MISSILE RANGE LIES IN THE TULAROSA BASIN, BUT THE NORTHWEST CORNER IS IN ANOTHER BASIN WITH SOMEWHAT SIMILAR TOPOGRAPHY, THE JORNADA DEL MUERTO.

TABLE I, INDEX OF WEATHER STATIONS

STATION	LATITUDE		LONGITUDE		ELEVATION	COUNTY	PERIOD OF RECORD **
Afton *	32°	03'	106°	52'	4200 Ft.	Dona Ana	1942-58
Alamogordo	32	53	105	57	4350	Otero	1931-58
Ancho *	33	56	105	45	6112	Lincoln	1931-58
Bingham	33	53	106	22	5453	Socorro	1939-58
Bosque del Apache	33	46	106	54	4520	Socorro	1931-58
Caballo Dam	32	54	107	18	4190	Sierra	1936-58
Capitan	33	33	105	34	6350	Lincoln	1931-58
Carrizozo	33	39	105	53	5438	Lincoln	1931-58
Cloudcroft R. S.	32	57	105	44	8700	Otero	1931-58
Engle	33	11	107	02	4770	Sierra	1931-52
Ft. Stanton	33	30	105	31	6230	Lincoln	1931-58
Hardin Ranch *	33	15	106	44	6000	Socorro	1942-52
Hatch	32	40	107	09	3855	Dona Ana	1931-58
Holloman AFB	32	51	106	06	4092	Otero	1944-57
Jornada Ex. Range	32	37	106	44	4265	Dona Ana	1931-58
Lulu *	32	26	105	37	5000	Otero	1942-58
Mayhill R. S.	32	55	105	28	6538	Otero	1931-58
Mescalero	33	10	105	48	6565	Otero	1931-58
Mountain Park	32	57	105	50	6720	Otero	1931-58
New Mexico State University	32	17	106	45	3909	Dona Ana	1931-58
Orogrande	32	22	106	05	4180	Otero	1931-58
Ruidoso	33	20	105	40	6875	Lincoln	1942-58
Tularosa	33	04	106	02	4450	Otero	1931-58
White Sands National Monument	32	47	106	10	399[illegible]	Otero	1939-58
WSMR Air Weather "A" Station	32	23	106	29	4238	Dona Ana	1947-57
El Paso, Texas	31	48	106	24	3920	El Paso	1940-58
SUPPLEMENTARY WIND STATIONS							
NORTHWEST-30	32	53	106	30	4000	Dona Ana	
OSCURA RANGE CAMP	33	30	106	10	4515	Otero	
S R - VAN	32	38	106	24	3955	Dona Ana	
TULA	33	04	106	09	4130	Otero	

* Rainfall records only.

** In some cases periods of record are not continous, and may differ in length for various elements.

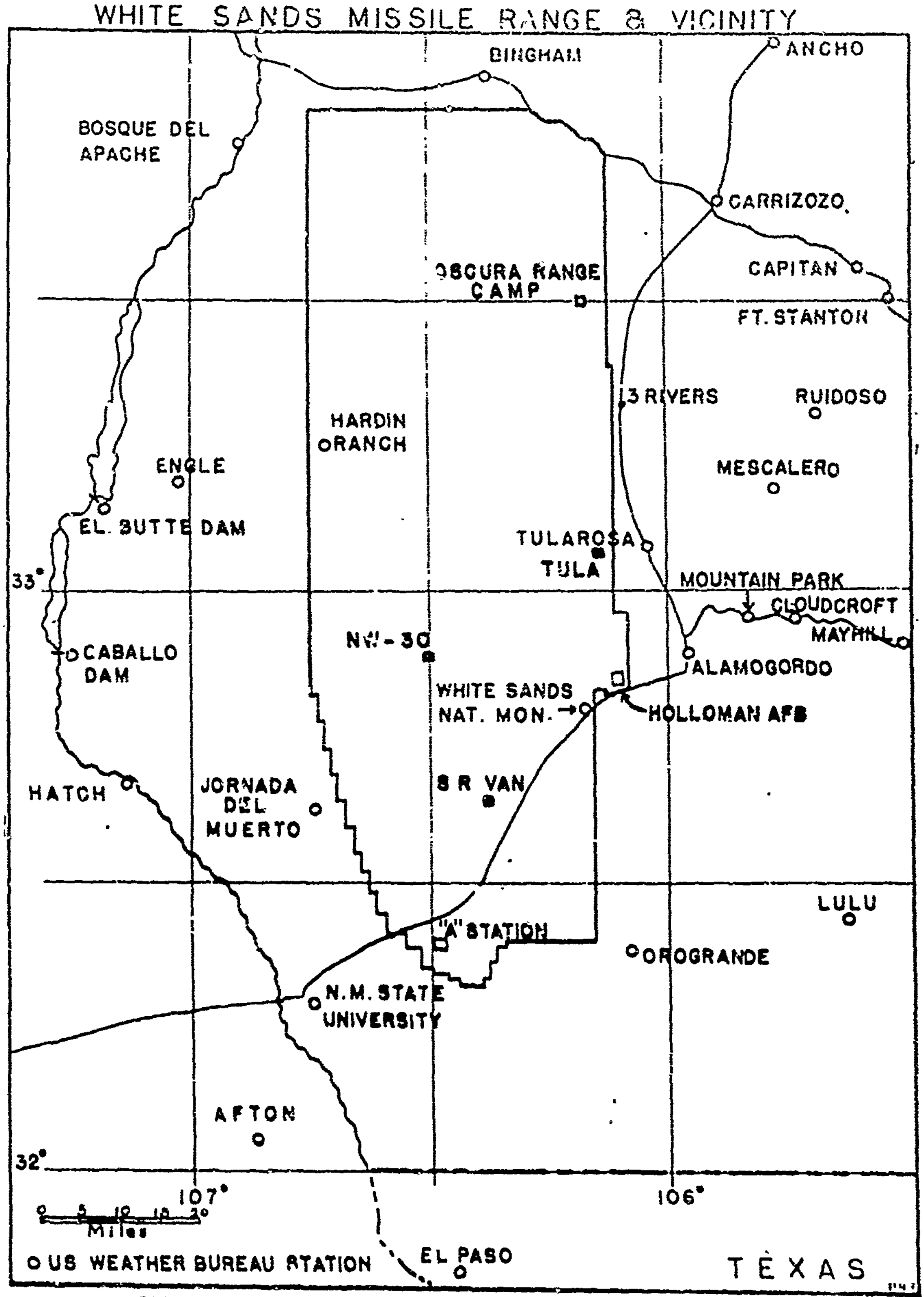


FIG. 1 MAP OF WEATHER STATIONS

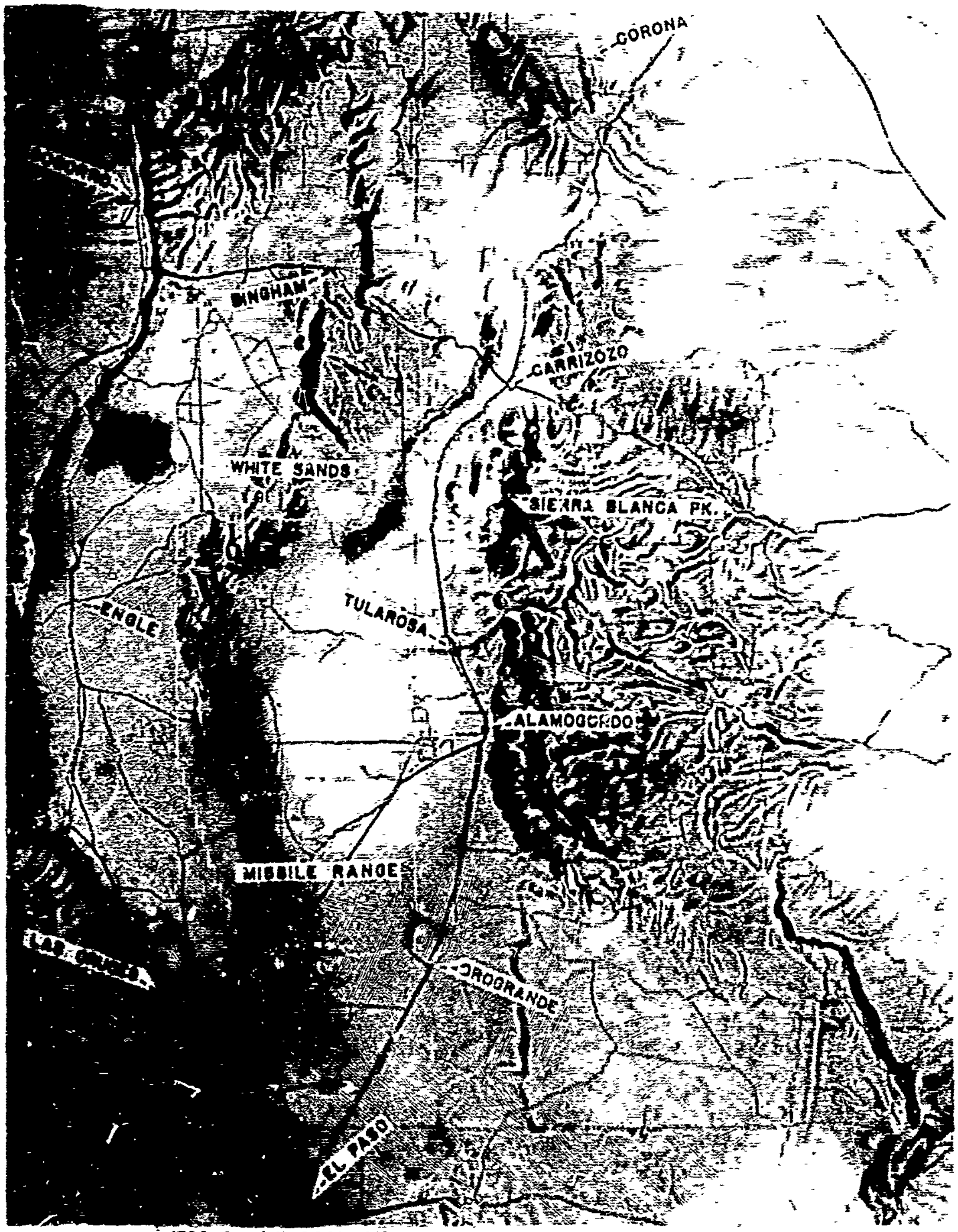


FIG. 2. TOPOGRAPHY OF TULAROSA BASIN & VICINITY

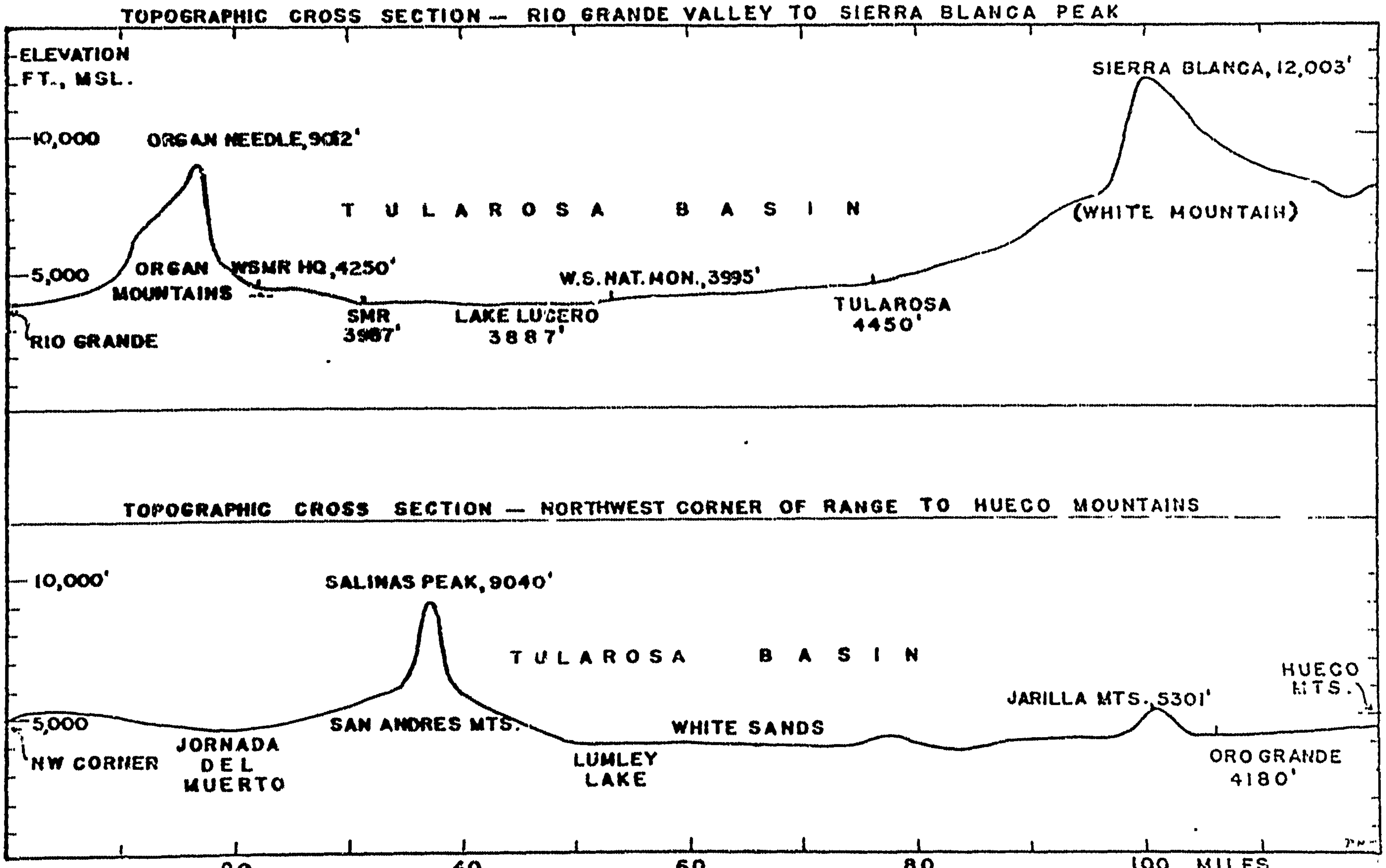


FIG. 3 TOPOGRAPHIC CROSS SECTIONS, WHITE SANDS MISSILE RANGE

(2)

The unique feature of the Tularosa Basin is the presence in its central portion of extensive deposits of gypsum, derived from the wind erosion of selenite crystals which formed in a lake bed as that body of water evaporated over a period of perhaps several millenia. The predominate character of the soil in the remainder of the basin is sandy, but in the northern portion there is an extensive lava flow. At the lower elevations vegetation consists mainly of mesquite, greasewood, scrub oak, yucca, cactus, many sparse grasses and small desert herbs; above 7,000 feet MSL rainfall is sufficient to support considerable growths of juniper, pine, and fir. (The isohyets of Figure 4 are based on the fact that junipers and conifers require annual rainfall of at least 13 - 20 inches to produce any growth except when widely scattered [27].)

The variation in types of soil and in distribution of vegetation contribute a marked effect on surface reflectivity and absorption and on small-scale perturbations which are due to unequal heating.

The basin has an arid climate with annual rainfall averaging less than 10 inches (Fig. 4), and a mean annual temperature of about 60 degrees. Considerable drainage occurs from the nearby mountains during infrequent but sometimes prolonged wet spells, occasionally producing intermittent lakes which may persist for several months.

LOCAL WIND EFFECTS IN THE TULAROSA BASIN

Several factors enter into the variability of the surface winds in the Tularosa Basin. Only a summarization of the individual items will be included in this study due to the complex nature of the meteorological conditions which cause the variations in the wind.

Seasonal variation is large, with the strongest sustained winds occurring in the late winter and spring months. This is primarily because of entrainment of the surface winds with the strong westerly winds aloft and the nature of the terrain on the western boundary of the basin. In the summer months the surface winds are lighter except for the short term variations caused by thunderstorms and dust devils.

The variability caused by frontal activity is generally confined to the winter and spring months, contributing to the stronger winds observed during these months. The most common fronts are of the "cold" type, entering the basin from the northwest after an extensive trajectory over mountainous terrain. Other cold fronts enter the Basin from the north and east, but the Arctic air masses are usually deflected to the east of the basin by the Sacramento Mountains and by the Sangre de Christo Mountains in northeastern New Mexico.

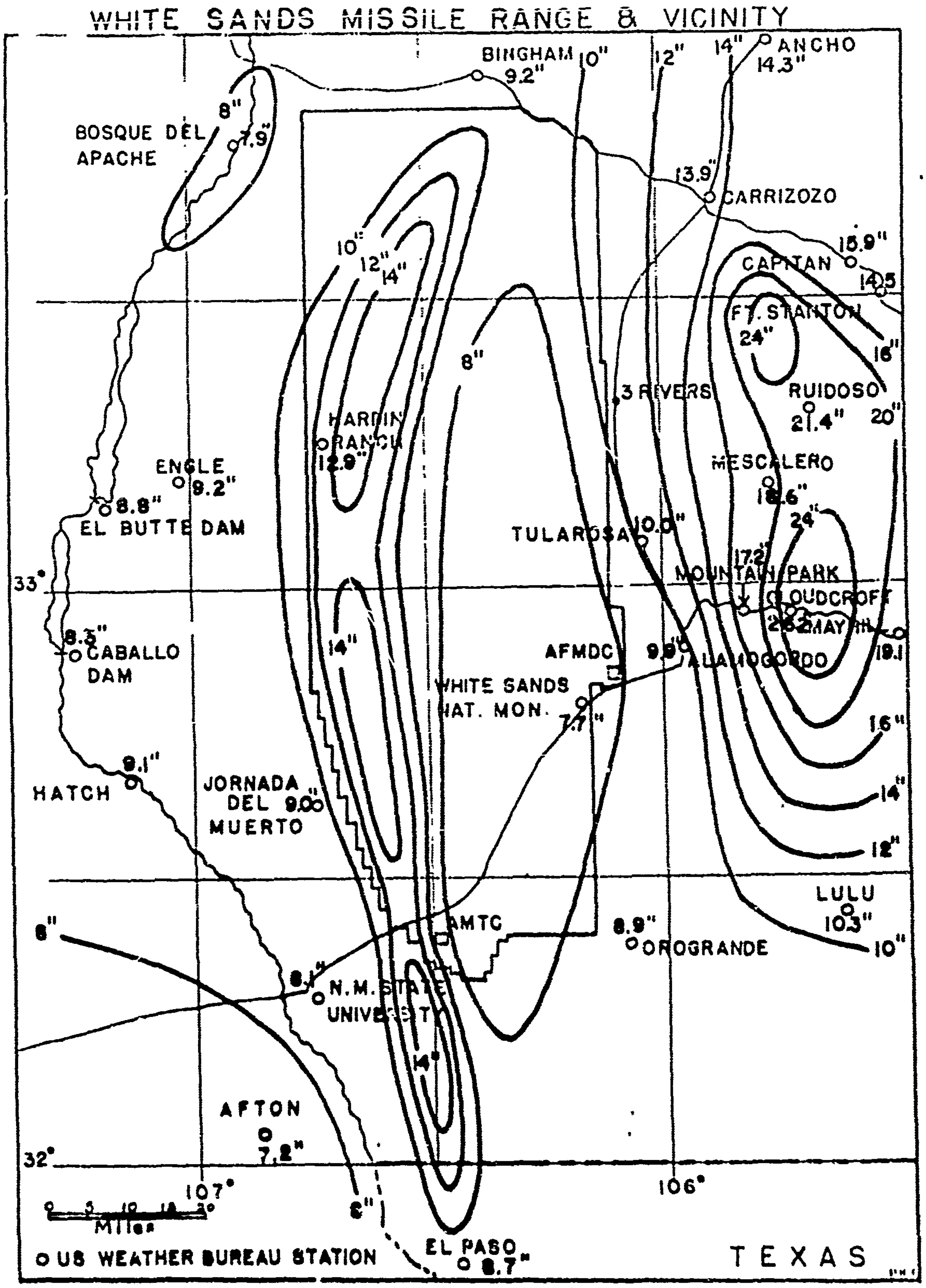


FIG. 4 MEAN ANNUAL PRECIPITATION, WSMR

In the late spring and summer months numerous dust devils occur, and it is not unusual to see as many as ten dust columns in the basin at one time. The effect of the dust devils on the surface wind at one point usually lasts one minute or less, but the direction of the wind may shift as much as 360 degrees and the wind speed may exceed 50 miles per hour. Maximum recorded gusts with a dust devil at the White Sands Missile Range Weather Station has been 55 miles per hour. The common wind pattern during the dust devil season consists of short periods of calm followed by random light winds; however, dust devils with vortices up to 200 feet in diameter are not uncommon when general surface winds exceed 40 miles per hour.

Thunderstorm activity contributes considerably to the surface wind variability, with the season of maximum occurrence from June through September. The most common type of thunderstorm is caused by a combination of orographic lifting and convection, and the usual life period extends from approximately 1200 to 0200 MST. This type of thunderstorm develops over the adjacent mountains with subsequent movement dependent upon the winds aloft. Updrafts and downdrafts are always present with thunderstorms, and blowing dust and sand are common. Hail and moderate to heavy rain frequently accompany the thunderstorms and contribute further to the surface wind variability by differential cooling of the mountains and portions of the basin. Other thunderstorms occur with frontal passages and in periods of marked convergence aloft, but these storms are in the minority.

The surface winds are affected on the microscale by the rough terrain of the basin floor. Surface friction and roughness result in extensive eddy currents and low-level turbulence.

One of the more predominant factors affecting wind variability in the basin lies in the effects of the adjacent mountain ranges. Drainage winds of less than 15 miles per hour are common on the slopes of the mountains and over the first few miles of the basin floor. These winds may reach velocities as high as 30 to 40 miles per hour when the pressure gradient and drainage slope are in the same direction. The drainage winds are diurnal in nature [27], occurring generally from midnight until 4 or 5 hours after sunrise; areas on the foothills of the mountains may experience drainage winds as early as the onset of darkness and lasting until 4 or 5 hours after sunrise.

Funnel effect winds are common during the late winter and throughout the spring months in the lee of the numerous passes on the western side of the basin, with velocities occasionally in excess of [illegible] miles per hour. Structural damage of minor nature may result from these winds, and considerable blowing dust and sand occurs over periods of from one to three days. The eastern side of the basin is affected to a lesser extent because of the preponderance of strong westerly winds aloft.

Foehn winds commonly occur because of the extensive mountain barriers along the western boundary of the basin. The strong westerly winds aloft in winter and spring months are forced over the mountains, causing frequent cloudiness and occasional precipitation over the peaks and ridges. [illegible] warm

DOWNSLOPE WINDS ON THE EAST SIDE OF THE RANGES. STANDING WAVES OFTEN FORM IN THE LEE OF THE WESTERN BARRIER, WITH PERTURBATIONS IN THE UPPER FLOW EXTENDING EASTWARD AS FAR AS THE SACRAMENTO MOUNTAINS SOME 50 MILES DISTANT. AS MANY AS NINE ROWS OF WAVE CLOUDS HAVE BEEN OBSERVED IN THE LEE OF THE SHARP RIDGE FORMED BY THE ORGAN MOUNTAINS. FREQUENTLY THE DRY AIR ALOFT PREVENTS THE FORMATION OF WAVE CLOUDS, BUT NUMEROUS BALLOON ASCENTS HAVE REVEALED THE PRESENCE OF THE WAVES. THE LEE WAVE EFFECTS ALOFT ARE TRANSMITTED TO THE SURFACE WINDS THROUGH ENTRAINMENT AND TURBULENCE AND WILL CAUSE CONSIDERABLE VARIATION IN THE SURFACE WIND SPEED, PARTICULARLY IN THE WESTERN PORTION OF THE BASIN.

COLLECTION OF SURFACE WIND DATA AT REGULARLY-STAFFED STATIONS IN THE TULAROSA BASIN

SURFACE WIND DATA FOR EACH OF THE THREE REGULARLY-STAFFED WEATHER STATIONS IN THE TULAROSA BASIN ARE PRESENTED IN APPENDIX A AND ARE BASED ON PUBLICATIONS OF THE U. S. WEATHER BUREAU NATIONAL WEATHER RECORDS CENTER, ASHEVILLE, NORTH CAROLINA [4, 5] AND ON A SUMMARY PUBLISHED BY THE WEATHER STATION AT HOLLOMAN AIR DEVELOPMENT CENTER, NEW MEXICO [6]. THE PERIODS OF RECORD FOR THE STATIONS WERE:

AIR WEATHER "A" STATION,
WHITE SANDS MISSILE RANGE, N. M. ---------------SEPTEMBER 1947 MARCH 1955

HOLLOMAN AIR DEVELOPMENT CENTER N.M. -- SEPTEMBER 1942 - OCTOBER 1956

WEATHER BUREAU AIRPORT STATION
EL PASO, TEXAS ------------------------------ JANUARY 1950 - DECEMBER 1955

INCLUDED IN THE DATA ARE

1. GRAPHICAL PRESENTATIONS OF PERCENTAGE FREQUENCY OF OCCURRENCE BY SPEED GROUPS, BY MONTHS, AND AN ANNUAL AVERAGE.

2. AVERAGE WIND SPEEDS IN MILES PER HOUR FROM SIXTEEN DIRECTIONS, BY MONTHS, AND AN ANNUAL AVERAGE. THESE ARE REFERRED TO AS WIND ROSES. HOLLOMAN AIR DEVELOPMENT CENTER AVERAGE SPEEDS ARE NOT INCLUDED.

THE SCALE OF PERCENTAGE ON THE WIND ROSES IS ONE PERCENT FOR ONE-FOURTH INCH. AVERAGE WIND SPEEDS IN MILES PER HOUR ARE ENTERED AT THE END OF THE PERCENTAGE BARS. PERCENTAGE OF OCCURRENCE OF CALM CONDITIONS ARE ENTERED

ABOVE THE ROSES. THE HIGH PERCENTAGE OF CALMS AT WHITE SANDS MISSILE RANGE AND AT HOLLOMAN IS PROBABLY DUE TO THE THRESHOLD CHARACTERISTICS OF THE WIND INSTRUMENTS IN USE AT THOSE STATIONS.

INSTRUMENTATION, AIR WEATHER "A" STATION WSMR, N.M.

THE WIND EQUIPMENT IN USE AT THE AIR WEATHER "A" STATION DURING THE PERIOD OF RECORD WAS THE AN/GMQ-1 WIND MEASURING SYSTEM. IT CONSISTED OF A WIND TRANSMITTER ML-203-B AND A WIND PANEL ML-204-B. THE TRANSMITTER WAS A MEASURING AND TRANSMITTING INSTRUMENT IN WHICH AN ANEMOMETER AND WIND VANE WERE ASSEMBLED TO COMPRISE A SINGLE UNIT. THE ANEMOMETER CONSISTED OF A THREE-CUP ROTOR AND AN ANEMOMETER HEAD WHICH WAS AN ALTERNATING CURRENT GENERATOR DRIVEN BY MEANS OF THE CUP ROTOR THROUGH A SYSTEM OF GEARS. IT WAS PLUGGED INTO THE MAIN SHAFT OF THE WIND VANE AND HELD TIGHTLY IN PLACE BY A THUMBSCREW. THE WIND VANE CONSISTED OF A TAIL AND COUNTERBALANCE ATTACHED TO AN ASSEMBLY CONTAINING A SYNCHRO-TYPE TRANSMITTER OPERATED ON DIRECT CURRENT. THE WIND PANEL, INDICATING UNIT OF THE SET, WAS COMPOSED OF A SMALL WOODEN BOX WITH A HINGED PANEL ON WHICH WERE MOUNTED TWO INDICATORS AND TWO SWITCHES. THE DIRECTION INDICATOR WAS A SYNCHRO-TYPE INSTRUMENT, WHILE THE SPEED INDICATOR IS A RECTIFIER TYPE AC MILLIAMMETER HAVING A ONE MILLIAMPERE DC MOVEMENT. THE SPEED INDICATOR WAS CALIBRATED IN TWO SCALES, ONE FROM 2 TO 30 MPH AND THE OTHER FROM 2 TO 150 MPH. THE OVERALL ACCURACY OF THE SET WAS AS FOLLOWS

THRESHOLD SPEED TO 30 MPH ------------------- ±1/2 MPH

30 TO 75 MPH ------------------------------- ±3 MPH

75 TO 150 MPH ----------------------------- 4 PERCENT OF SCALE READING.

(THESE FIGURES WERE BASED ON WIND TUNNEL TESTS BY THE U. S. BUREAU OF STANDARDS.)

OBSERVATIONAL HOURS VARIED DURING THE SAMPLING PERIOD, HOWEVER, FOR THE MOST PART THE OBSERVATIONS WERE MADE AT ONE-HOUR INTERVALS, 24 HOURS EACH DAY. NEAR THE END OF THE PERIOD, THE OBSERVATIONAL PROGRAM WAS SHORTENED TO 16 HOURS PER DAY, BEGINNING AT 0000 HOURS MST. THE WIND VALUES ARE 1-MINUTE AVERAGES AS READ FROM THE INDICATOR DIALS. AN APPARENT BIAS TOWARD RECORDING CARDINAL WIND DIRECTIONS MAY BE SEEN IN THE STATION WIND ROSE.

EXPOSURE WAS SATISFACTORY, BUT SOME EDDY EFFECTS WERE CAUSED BY THE WEATHER OBSERVATORY BUILDING UPON WHICH THE TRANSMITTERS WERE MOUNTED AND BY SEVERAL LARGE BUILDINGS TO THE SOUTHWEST AND NORTHWEST OF THE INSTRUMENTATION. THE TRANSMITTERS WERE MOUNTED AT A HEIGHT OF 27 FEET ON A STANDARD MOUNT ON THE ROOF OF "A" STATION. LOCAL EFFECTS WERE SIGNIFICANT BECAUSE OF THE PROXIMITY OF THE ORGAN MOUNTAINS WHOSE FOOTHILLS RISE 2-1/2 MI. EAST THE SOUTHWEST OF THE STATION. MARKED DRAINAGE WINDS, STRONG FUNNEL EFFECT WINDS, LEE WAVES, FOEHN WINDS, AND DOWNDRAFTS FROM OROGRAPHIC THUNDERSTORMS WERE ALL SIGNIFICANT AT THIS STATION.

INSTRUMENTATION HOLLOMAN AIR DEVELOPMENT CENTER, NEW MEXICO

Two sets of instrumentation were utilized at Holloman Air Development Center during the period September, 1942 through October, 1956. The original installation consisted of a British-type wind system with separate wind direction and wind speed transmitters. These instruments were located on individual mounts on top of the Base Fire Station at a height of 55 feet. The instantaneous wind values were transmitted to an R-33 recorder. In 1955 the wind equipment in use was replaced by a Wind Measuring Set AN/GMQ-11 and the installation was moved to a site in the center of the landing area.

The Wind Direction and Speed Transmitter, T-420/GMQ-11 (Aerovane) is a dual purpose instrument which measures and electrically transmits wind speed and direction. The speed was measured by a three-bladed impeller fastened to the armature of a tachometer magneto located in the nose of the vane. (The speed of rotation of the impeller is directly proportional to the speed of the wind striking the blades, thus, voltage generated by the magneto is a function of wind speed. When the generated voltage is measured by a voltmeter calibrated in terms of wind speed, the speed of the wind is indicated.) Wind direction was measured by a streamlined vane coupled to the rotor of a synchro motor. This motor electrically transmitted the position of the vane to a similar synchro motor in an indicator; thus, angular displacements were measured, transmitted, and indicated.

The Wind Direction and Speed Indicator ID-373/GMQ-11 located in the weather station consisted of two units, the panel assembly and the rack in which the panel was mounted. The panel assembly contained the wind direction and wind speed meters that were activated by the T-420/GMQ-11.

The location of the wind instrumentation, near the intersection of the major runways on the airfield was one-half mile from the nearest building and the exposure was excellent. The standard mount supported the Aerovane at 15-1/2 feet above the ground. The terrain was very flat with very low vegetation, for several miles in every direction. Local wind effects were primarily surface friction turbulence, downdrafts from orographic thunderstorms, and drainage winds from the Sacramento Mountains which rise eleven miles east of the airport. Lee waves due to strong westerly winds crossing the San Andres Range twenty-six miles to the west were considerably modified, and foehn winds and funnel effect winds were not common.

WIND INSTRUMENTATION WEATHER BUREAU AIRPORT STATION EL PASO, TEXAS

The wind instrumentation in use at the El Paso Municipal Airport during the period 1950 through 1955 consisted of the transmitter components of a 420-A wind system. The wind speed indicator was a Triplett Model 626 meter and the wind direction indicator was a Bendix-Friez direction dial. The transmitters were located 100 feet above the ground on the control tower,

ATOP THE TERMINAL BUILDING. THE WIND DIRECTION TRANSMITTER WAS A SYNCHRO-TYPE INSTRUMENT; THE WIND SPEED TRANSMITTER WAS A MAGNETO-GENERATOR ANEMOMETER. THESE INSTRUMENTS ARE DESIGNED TO TRANSMIT INSTANTANEOUS VALUES TO REMOTE STATIONS. FOR RECORD PURPOSES, ONE-MINUTE AVERAGE WIND SPEED VALUES WERE TABULATED AT ONE-HOUR INTERVALS, TWENTY-FOUR HOURS EACH DAY.

THE EXPOSURE OF THE WIND INSTRUMENTS WAS CONSIDERED [illegible], WITH SOME EFFECT ON WIND VALUES DUE TO EDDY CURRENTS OVER THE TERMINAL BUILDING AND NEARBY HANGARS. THE INSTRUMENTATION WAS MOUNTED CONSIDERABLY HIGHER HERE THAN THAT AT OTHER SITES UTILIZED IN THIS STUDY, RESULTING IN A SMALLER SURFACE FRICTION EFFECT AT THIS STATION. THE AREA IMMEDIATELY SURROUNDING THE EL PASO AIRPORT IS RATHER FLAT, WITH THE FRANKLIN MOUNTAINS RISING [illegible] MILES WEST OF THE TERMINAL BUILDING. LOCAL EFFECTS ON THE SURFACE WINDS WERE DUE TO SURFACE FRICTION, FUNNEL EFFECT, FOEHN WINDS, DOWNDRAFTS FROM OROGRAPHIC THUNDERSTORMS AND INDIRECT EFFECTS CAUSED BY LEE WAVES. THE EFFECTS OF THESE FACTORS WERE LESSENED CONSIDERABLY DUE TO THE DISTANCE BETWEEN THE WIND INSTRUMENTATION AND THE MOUNTAINS.

SPATIAL VARIABILITY OF SURFACE WIND AT WHITE SANDS MISSILE RANGE

TO OBTAIN A DETAILED STUDY OF SPATIAL VARIABILITY OF SURFACE WIND, STANDARD INSTRUMENTATION WAS INSTALLED AT FOUR SITES SELECTED TO REPRESENT VARIOUS PORTIONS OF THE MISSILE RANGE (FIG. 1).

AEROVANE TRANSMITTERS WERE USED TO RELAY WIND SPEED AND DIRECTION TO MODIFIED RO-2/GMQ RECORDERS AT EACH OBSERVATIONAL SITE. THE RO-2/GMQ INSTRUMENTS WERE TWO-ELEMENT RECORDERS THAT SIMULTANEOUSLY PRODUCED [illegible] INKED TRACES OF WIND DIRECTION AND SPEED VALUES ON A [illegible] PAPER CHART. THE OBSERVATIONAL PROGRAM WAS [illegible] THROUGH AN INTER-COMMUNICATION SYSTEM CONNECTING ALL SAMPLING STATIONS.

GRAPHS OF WIND SPEED AND DIRECTION [illegible] ARE INCLUDED IN APPENDIX A. ON MOST DATES [illegible] THAN THE FOUR [illegible] STATIONS WERE OPERATED. THE SAMPLING PERIODS WERE [illegible] THE EARLY MORNING HOURS WHEN THE ATMOSPHERE NEAR THE SURFACE [illegible] STABLE CONDITION. (SEASONAL VARIABILITY IS NOT SHOWN SINCE ONLY A RELATIVELY SHORT PERIOD WAS COVERED BY THIS STUDY.)

TEMPERATURES IN THE TULAROSA BASIN

Temperatures are characteristic of a continental type climate with quite high maxima and low minima, resulting in a large diurnal temperature range. The average daily temperature range for White Sands National Monument (Table II and Fig. 5) amounts to 37.2°, from a mean daily minimum for the year of 41.2°F to a mean maximum of 78.4°F. This diurnal range is remarkably consistent during the entire year, varying only from 33.5°F in January to 40.8°F in November. The lowest and highest temperatures of record for this station show an extreme range of 124°, from -14°F to 110°F for only eighteen years of record. Figures 6 and 7 are isotherm charts for January and July for the area.

RAINFALL FOR THE BASIN AREA

The precipitation records (Table III and Fig. 8) show the great variability in rainfall from month to month and year to year, with the rainfall for wet years as much as seven times as great as during dry years at some stations. The greatest monthly (or even the greatest 24-hour) precipitation at times has exceeded the total annual rainfall during drought periods at several locations.

Precipitation is of the continental type (Fig. 9), with 50 percent of the annual total occurring in the months of July, August and September, and 72 percent in the warm season from May through October. This summer rainfall is occasioned by the establishment during those months of a flow of warm moist air from the Gulf of Mexico toward the semi-permanent low, centered in southern Arizona. The combination of upslope flow, orographic lifting and convective activity, along with the high afternoon temperatures, set off many afternoon, evening and nighttime thundershowers which account for most of the rainfall of this period. Occasionally, advectional thunderstorms occur in connection with cold fronts which invade the area.

Several times in the past, tropical storms have moved into southern Texas or northern Mexico from the Gulf of Mexico, and continuing northwestward, have invaded southern New Mexico, producing torrential down-pours (Figs. 10 and 11) and destructive flash floods [1] as in September 1941. (It will be noted in Table III that a large proportion of the greatest 24-hour and monthly rainfall occurred in that month.)

TABLE II
TEMPERATURE MEANS AND EXTREMES

STATION	YEARS	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
ALAMOGORDO	24	MEAN:	42.5	46.7	52.5	59.9	69.5	78.3	79.9	79.1	73.1	62.5	49.0	45.2	61.4
		HIGHEST:	79	80	91	96	104	109	110	108	102	98	84	78	110
		LOWEST:	-8	1	10	20	30	41	49	48	33	23	8	-1	-[illegible]
BINGHAM	17	MEAN:	36.2	38.8	44.9	54.0	63.3	72.6	75.9	74.3	68.7	57.5	43.5	37.2	[illegible]
		HIGHEST:	70	72	82	89	98	101	103	100	98	89	80	70	[illegible]
		LOWEST:	-8	-8	8	13	26	30	45	47	25	18	7	-3	-[illegible]
BOSQUE DEL APACHE	24	MEAN:	38.2	43.1	49.9	58.5	66.0	74.5	78.5	76.6	69.6	58.[illegible]	45.4	[illegible]	[illegible]
		HIGHEST:	80	85	90	100	105	113	110	110	106	97	89	77	[illegible]
		LOWEST:	-9	-4	9	11	20	34	47	43	29	20	6	-[illegible]	-9
CABALLO DAM	21	MEAN:	42.0	46.3	51.8	60.5	68.7	77.9	81.0	79.2	73.2	62.7	49.4	[illegible]	61.3
		HIGHEST:	85	80	90	95	105	108	108	106	105	92	86	[illegible]	[illegible]
		LOWEST:	-6	9	13	23	32	41	52	52	33	29	14	[illegible]	[illegible]
CAPITAN	11	MEAN:	30.4	33.9	40.2	47.7	56.8	65.1	67.7	65.0	60.0	[illegible]	[illegible]	[illegible]	[illegible]
		HIGHEST:	65	66	78	81	90	96	98	96	92	[illegible]	[illegible]	[illegible]	[illegible]
		LOWEST:	-10	-12	6	10	21	30	41	41	28	[illegible]	-1	-4	[illegible]
CARRIZOZO	26	MEAN:	37.3	41.4	46.8	54.9	63.7	72.7	75.5	[illegible]	67.9	[illegible]	44.0	[illegible]	[illegible]
		HIGHEST:	72	76	86	92	98	106	110	102	100	95	[illegible]	[illegible]	[illegible]
		LOWEST:	-9	-5	4	15	24	36	40	46	30	[illegible]	2	[illegible]	[illegible]
CLOUDCROFT	25	MEAN:	30.6	32.5	36.7	43.7	51.5	59.7	60.4	59.3	55.6	[illegible]	[illegible]	[illegible]	[illegible]
		HIGHEST:	64	66	70	75	85	89	87	85	85	[illegible]	66	[illegible]	[illegible]
		LOWEST:	-10	-11	-2	6	16	27	36	34	23	12	-7	[illegible]	[illegible]
ENGLE	19	MEAN:	37.7	43.9	49.6	58.0	66.4	75.0	78.6	76.9	70.6	59.7	46.5	40.1	[illegible]
		HIGHEST:	75	77	87	93	101	108	110	105	99	93	66	83	110
		LOWEST:	-8	4	14	20	30	40	51	52	31	24	6	9	[illegible]
FT. STANTON	25	MEAN:	34.9	38.4	43.1	50.9	58.9	67.6	70.2	68.7	63.1	53.4	42.2	36.7	[illegible]
		HIGHEST:	76	75	84	86	94	105	101	96	95	90	82	73	[illegible]
		LOWEST:	-21	-19	-3	12	19	31	40	35	27	13	-3	-16	[illegible]
HATCH	25	MEAN:	41.1	45.4	51.8	60.0	67.7	76.2	79.4	77.7	71.5	61.2	48.4	41.9	[illegible]
		HIGHEST:	77	81	90	97	102	108	110	105	103	99	69	78	110
		LOWEST:	-4	3	6	20	30	32	49	50	53	27	7	-1	[illegible]
HOLLOMAN AFB*	14	MEAN:	41.8	45.1	52.1	61.6	69.7	79.0	81.2	80.3	74.0	62.3	49.0	42.0	61.6
		HIGHEST:	79	80	87	95	103	107	107	105	105	93	81	75	107
		LOWEST:	-5	0	11	22	30	44	54	55	38	30	12	2	-5

* From [illegible] Technical Report, TR 57-2

TABLE II--CONTINUED
TEMPERATURE MEANS AND EXTREMES

STATION	YEARS	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
JORNADA	27	MEAN:	39.5	44.0	51.7	57.9	66.2	75.6	79.4	77.7	71.3	60.3	46.7	40.2	59.2
EXPERIMENTAL		HIGHEST:	79	85	88	94	104	109	110	105	102	94	88	74	110
RANGE		LOWEST:	-20	3	5	15	24	31	50	44	30	20	3	-4	-20
MAYHILL RANGER	17	MEAN:	37.6	39.9	43.2	50.2	58.3	66.6	68.4	67.3	62.5	54.0	43.5	39.1	52.6
STATION		HIGHEST:	77	74	80	85	93	98	97	94	94	84	78	74	98
		LOWEST:	-16	-13	-5	9	25	36	42	39	27	18	0	-6	-16
MESCALERO	23	MEAN:	34.1	37.5	41.6	49.3	56.6	64.7	66.8	65.5	61.3	52.6	42.1	36.0	51.5
		HIGHEST:	70	70	76	84	93	98	98	100	89	90	80	68	100
		LOWEST:	-10	-10	4	10	18	30	38	34	26	17	-2	-8	-10
MOUNTAIN PARK	26	MEAN:	36.4	38.8	43.7	51.7	59.0	67.5	68.7	67.3	63.3	54.6	44.0	38.7	52.7
		HIGHEST:	68	70	80	87	93	98	101	93	92	84	80	71	101
		LOWEST:	-6	-10	5	10	23	30	47	39	31	21	6	0	-10
NEW MEXICO STATE	28	MEAN:	40.9	45.5	50.9	59.2	67.2	76.3	79.5	77.7	71.4	61.0	47.6	42.0	59.9
UNIVERSITY		HIGHEST:	78	85	90	94	103	107	109	103	102	93	83	77	109
		LOWEST:	-8	2	12	20	27	36	42	44	30	22	5	[illegible]	-8
OROGRANDE	27	MEAN:	42.4	47.1	53.5	61.9	70.9	80.5	82.6	80.6	74.3	64.2	49.3	43.1	62.[illegible]
		HIGHEST:	76	80	92	94	105	110	110	110	105	94	81	75	110
		LOWEST:	-11	9	6	20	34	50	52	50	46	28	17	1	-11
RUIDOSO	15	MEAN:	33.3	35.5	39.5	46.5	53.8	62.4	65.1	63.6	58.1	49.2	38.9	34.0	48.[illegible]
		HIGHEST:	74	72	76	83	92	97	95	92	91	81	74	72	97
		LOWEST:	-21	-26	-8	5	16	25	36	32	22	11	-11	-14	[illegible]
TULAROSA	25	MEAN:	43.6	47.4	52.6	60.8	69.2	78.3	80.5	78.6	73.1	63.0	49.8	44.6	61.8
		HIGHEST:	89	80	86	98	103	111	108	107	100	99	86	78	111
		LOWEST:	-4	5	12	18	28	42	50	42	32	22	11	0	-4
WHITE SANDS	18	MEAN:	39.9	44.1	50.4	59.1	68.1	77.3	80.4	78.8	72.4	60.4	46.5	40.0	[illegible]
NATIONAL		HIGHEST:	75	82	91	97	104	109	110	107	105	95	86	84	110
MONUMENT		MEAN MAX:	55.9	63.5	69.9	79.1	88.2	96.1	97.2	95.7	90.1	79.3	66.8	58.9	78.4
		LOWEST:	-8	-14	9	11	25	38	50	48	30	21	1	-8	-14
		MEAN MIN:	22.4	24.4	30.3	39.3	48.8	58.1	63.6	62.4	55.1	41.7	26.0	22.2	41.2
EL PASO AIRPORT	19	MEAN:	43.4	49.1	54.5	63.1	71.6	80.2	81.3	79.8	74.9	65.2	52.0	44.8	63.3
STATION--U. S.		HIGHEST:	75	81	88	95	104	107	107	103	103	93	84	76	107
WEATHER BUREAU		LOWEST:	-6	8	18	28	38	50	60	59	41	32	16	5	-6

TABLE III PRECIPITATION MEANS AND EXTREMES

STATION	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
AFTON	MONTHLY MEANS:	0.49	0.35	0.38	0 11	0.27	0 36	1.44	1.28	1.04	0.78	0 27	0 40	7 17
	* GREATEST MONTHLY:	1.77	1.28	2.52	0.67	1 27	1.84	3.28	2.83	4 59	1 92	1.00	1.40	15.47
16	YEAR:	1949	1948	1958	1952	1958	1943	1955	1957	1958	1944	1943	1946	1948
	GREATEST 24-HOUR:	0.77	0.72	1.00	0 51	1.01	1.15	1.43	1.37	2.61	1.18	1.00	1.26	-----
	YEAR:	1947	1958	1958	1952	1941	1943	1953	1942	1958	1944	1943	1946	-----
	LEAST ANNUAL:											IN 1956·		3.72
ALAMOGORDO	MONTHLY MEANS:	0.74	0 56	0.41	0.36	0 47	0.72	1 63	1.53	1.55	0.89	0.44	0.55	9.85
	GREATEST MONTHLY:	2.61	2.14	3.02	2.13	3.03	3.04	5.40	4.42	6.94	2.25	1.56	2.33	21.87
28	YEAR:	1949	1931	1958	1942	1941	1933	1955	1942	1941	1957	1946	1942	1941
	GREATEST 24-HOUR:	1.10	0.86	1.16	1.00	1.23	2.01	1.80	1.85	2.60	1.34	1.38	1.45	-----
	YEAR:	1916	1957	1958	1919	1941	1953	1954	1942	1941	1928	1923	1942	-----
	LEAST ANNUAL:											IN 1956:		2.93
ANCHO	MONTHLY MEANS:	0.99	0.75	0.99	0.88	1.03	1.04	1.96	2.13	1.85	1.03	0.63	0.97	14.25
	GREATEST MONTHLY:	3.60	2.35	3.54	5.20	6.35	3.80	4.70	3.74	10.41	4.20	1.96	2.40	34.40
28	YEAR:	1946	1948	1958	1942	1941	1937	1950	1942	1941	1932	1934	1943	1941
	GREATEST 24-HOUR:	1.00	1.12	1.10	1.55	2.75	3.25	3.25	1.90	2.90	2.21	1.05	1.20	-----
	YEAR:	1944	1937	1926	1942	1941	1937	1929	1935	1941	1939	1923	1943	-----
	LEAST ANNUAL:											IN 1956:		8.29
BINGHAM	MONTHLY MEANS:	0.35	0.31	0.50	0.40	0 47	0.44	1 71	2.06	1.34	0 89	0.36	0.35	9 18
	GREATEST MONTHLY:	1.05	1 14	2.11	1.19	2.67	1.80	3.02	4 19	4 07	2 43	1 25	1.01	17.23
19	YEAR:	1944	1948	1958	1953	1941	1943	1955	1954	1949	1954	1944	1943	1941
	GREATEST 24-HOUR:	0.66	0.62	0.95	0.63	0 74	0.76	1.31	1 53	2 02	1.78	0.69	0.66	-----
	YEAR:	1944	1941	1945	1953	1943	1943	1942	1954	1941	1954	1944	1947	-----
	LEAST ANNUAL:											IN 1956:		2.84
BOSQUE DEL APACHE	MONTHLY MEANS:	0.42	0.40	0.29	0 28	0.39	0.75	1.06	1 49	1.37	0.89	0.20	0.34	7.88
	GREATEST MONTHLY:	1.62	1 76	1.78	2.17	1.84	2 42	2 87	3 37	3.65	2.96	0 82	1.37	14.77
27	YEAR:	1941	1948	1958	1942	1958	1938	1957	1932	1941	1957	1935	1937	1941
	LEAST ANNUAL:											IN 1956:		2.72

* GREATEST MONTHLY AND ANNUAL. FIGURES BELOW STATION NAMES SHOW NUMBER OF YEARS OF RECORD.

TABLE III, PRECIPITATION MEANS AND EXTREMES

STATION	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
CABALLO DAM	MONTHLY MEANS:	0.36	0.46	0.32	0.28	0.40	0.58	1.62	1.62	1.45	0.68	0.21	0.34	8.32
	GREATEST MONTHLY:	2.13	1.84	1.49	0.97	2.33	2.52	3.33	4.31	4.76	4.02	2.74	1.16	18.82
22	YEAR:	1941	1937	1958	1941	1937	1938	1957	1954	1941	1958	1958	1943	1941
	GREATEST 24-HOUR:	1.19	1.55	0.77	0.72	1.09	1.23	2.56	2.37	2.31	1.01	0.47	0.78	----
	YEAR:	1941	1937	1953	1941	1949	1938	1945	1941	1941	1951	1944	1943	----
	LEAST ANNUAL:											IN 1951:		4.72
CAPITAN	MONTHLY MEANS:	0.73	0.80	0.97	0 85	1.34	1.44	2.59	2.52	2.82	0.86	0.43	0.58	15.93
	GREATEST MONTHLY:	2.35	2.09	3.07	2.86	4.59	3.78	5.89	5.71	10.71	4.07	1.41	3.12	30.74
25	YEAR:	1936	1939	1958	1942	1937	1938	1957	1932	1941	1957	1934	1931	1941
	GREATEST 24-HOUR:	1.29	0.91	2 36	1.12	2 16	2.05	2.67	2 32	4.81	1.23	0.90	1 10	----
	YEAR:	1926	1923	1941	1915	1937	1920	1950	1930	1941	1957	1913	1923	----
	LEAST ANNUAL:											IN 1951:		8 67
CARRIZOZO	MONTHLY MEANS:	0.74	0.76	0.81	0.70	0.92	1.16	2.21	2.28	1.95	1.00	0.57	0.75	13.85
	GREATEST MONTHLY:	2.90	3.51	2.75	4.87	2.83	4.08	4.07	7.93	9.69	4.02	1.76	3.05	35.60
27	YEAR:	1936	1931	1958	1931	1936	1933	1931	1935	1941	1931	1931	1931	1931
	GREATEST 24-HOUR:	1.28	1.10	1.11	1.16	1.60	1.12	2.23	2.28	3.52	1.85	1.20	1.30	----
	YEAR:	1941	1915	1926	1931	1954	1919	1938	1932	1941	1931	1923	1914	----
	LEAST ANNUAL:											IN 1945·		5.00
CLOUDCROFT	MONTHLY MEANS:	1.84	1.73	1 72	0 93	1.12	1.87	5.64	4.74	2.58	1 70	0.89	1 44	26.20
	GREATEST MONTHLY:	5.24	4.75	7.31	3.49	5.20	6.17	10.75	9.69	11.62	4.72	3.95	3 74	48.10
27	YEAR:	1946	1931	1958	1942	1941	1943	1950	1931	1941	1957	1931	1931	1941
	GREATEST 24-HOUR:	2.20	2.16	2.30	1.55	1.66	2.96	2.80	2.86	3.60	2.20	2.62	2.00	----
	YEAR:	1936	1931	1927	1942	1940	1943	1950	1931	1941	1926	1926	1948	----
	LEAST ANNUAL:											IN 1934:		17.15
ENGLE	MONTHLY MEANS:	0.40	0.54	0.30	0.36	0.61	0 62	1 69	1.92	1.36	0.75	0.21	0.41	9.15
	GREATEST MONTHLY:	1.78	2.03	1.97	2.52	3.20	2.88	5.93	5.08	3 62	2 46	0 85	1.41	16.02
27	YEAR:	1941	1948	1958	1931	1937	1938	1933	1957	1958	1958	1957	1942	1941
	GREATEST 24-HOUR:	1.27	1.06	1.12	1.20	2.18	1.40	2.63	4.40	4.20	1.34	1.50	1.25	----
	YEAR:	1941	1948	1899	1931	1937	1948	1933	1898	1904	1945	1898	1896	----
	LEAST ANNUAL:											IN 1953:		4 54

TABLE III PRECIPITATION MEANS AND EXTREMES

STATION	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
FT. STANTON	MONTHLY MEANS:	0.74	0.62	0.81	0.62	1.21	1.09	2.89	2.44	2.35	0.82	0.35	0.54	14.48
	GREATEST MONTHLY:	4.08	1.96	3.31	2.21	4.19	2.90	6.09	5.40	6.79	3.02	1.06	1.88	20.51
26	YEAR:	1944	1931	1958	1931	1937	1938	1957	1957	1941	1957	1944	1943	1931
	GREATEST 24-HOUR:	3.80	1.06	1.53	1.86	1.97	2.00	2.10	2.09	3.65	1.81	1.60	1.15	----
	YEAR:	1944	1891	1941	1935	1954	1912	1940	1909	1900	1902	1901	1943	----
	LEAST ANNUAL:											IN 1945:		6.06
HARDIN RANCH	MONTHLY MEANS:	1.00	0.60	0.22	0.37	0.34	1.13	2.63	2.78	1.53	0.89	0.44	0.94	12.87
	GREATEST MONTHLY:	2.92	2.57	0.56	0.93	0.80	5.74	5.23	4.27	3.66	1.51	1.90	2.82	20.13
9	YEAR:	1949	1948	1951	1946	1947	1943	1949	1942	1942	1945	1944	1943	1949
	GREATEST 24-HOUR:	0.64	1.16	0.35	0.49	0.59	2.60	1.73	1.37	1.15	1.03	0.75	1.53	----
	YEAR:	1946	1948	1947	1946	1948	1943	1949	1946	1946	1945	1946	1943	----
	LEAST ANNUAL:											IN 1945:		7.77
HATCH	MONTHLY MEANS:	0.47	0.43	0.29	0.37	0.31	0.54	1.73	1.77	1.42	0.99	0.23	0.50	9.05
	GREATEST MONTHLY:	2.51	2.01	1.13	3.28	1.18	3.38	6.32	5.80	5.34	3.94	1.15	1.66	18.22
21	YEAR:	1941	1931	1941	1931	1937	1933	1950	1957	1938	1957	1936	1932	1941
	GREATEST 24-HOUR:	1.25	1.07	1.21	1.40	1.19	1.35	1.98	2.00	2.05	1.62	0.69	1.51	----
	YEAR:	1941	1948	1911	1931	1954	1905	1950	1941	1958	1957	1913	1906	----
	LEAST ANNUAL:											IN 1956:		4.03
HOLLOMAN AIR FORCE BASE 14	MONTHLY MEANS:	0.49	0.37	0.12	0.18	0.38	0.83	0.96	0.79	0.96	0.61	0.22	0.40	6.31
	From HADC Report, TR 57-2													
JORNADO EXPERIMENTAL RANGE 28	MONTHLY MEANS:	0.56	0.44	0.29	0.26	0.30	0.56	1.61	1.54	1.54	0.94	0.40	0.51	8.95
	GREATEST MONTHLY:	1.68	1.57	2.17	2.02	1.24	2.84	5.80	4.75	4.49	2.26	1.40	1.50	17.74
	YEAR:	1941	1931	1958	1931	1934	1933	1938	1957	1941	1954	1944	1948	1941
	GREATEST 24-HOUR:	1.00	0.94	0.97	0.89	1.35	1.27	1.97	1.66	2.27	1.63	0.94	0.95	----
	YEAR:	1936	1949	1958	1941	1926	1952	1926	1932	1938	1922	1943	1948	----
	LEAST ANNUAL:											IN 1953:		3.10

TABLE III PRECIPITATION MEANS AND EXTREMES

STATION	DATA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
LULU	MONTHLY MEANS:	0.49	0.52	0.39	0.29	0.46	1.46	1.92	1.46	1.28	1.21	0.28	0.56	10.32
	GREATEST MONTHLY:	2.05	1.13	2.07	1.45	1.64	7.60	6.16	5.00	4.13	3.95	0.82	1.91	17.65
16	YEAR:	1946	1949	1958	1942	1944	1950	1950	1958	1946	1955	1943	1949	1950
	GREATEST 24-HOUR:	0.80	0.80	0.40	0.84	0.70	6.50	2.50	2.40	1.35	2.16	0.50	0.80	----
	YEAR:	1948	1955	1951	1952	1954	1950	1955	1957	1949	1947	1957	1951	----
	LEAST ANNUAL:											IN 1954:		3.79
MAYHILL RANGER STATION	MONTHLY MEANS:	0.76	0.76	0.83	0.62	1.24	1.83	3.47	3.82	3.13	1.45	0.40	0.74	19.05
	GREATEST MONTHLY:	3.39	2.28	3.15	4.23	5.08	4.30	8.72	9.30	13.43	4.24	1.43	2.70	42.96
28	YEAR:	1949	1931	1958	1931	1936	1943	1950	1931	1941	1957	1957	1943	1941
	GREATEST 24-HOUR:	1.16	1.24	1.70	1.37	2.14	2.51	2.40	2.59	3.46	2.35	1.11	[illegible]	----
	YEAR:	1938	1931	1937	1922	1940	1938	1924	1945	1932	1932	1926	1943	----
	LEAST ANNUAL:											IN 1956:		8.03
MESCALERO	MONTHLY MEANS:	0.88	1.00	0.96	0.75	0.95	1.39	3.56	3.78	2.32	1.27	0.70	1.00	18.56
	GREATEST MONTHLY:	2.62	3.42	3.97	3.60	4.10	4.67	7.06	9.50	6.17	3.86	1.98	3.01	35.19
25	YEAR:	1936	1931	1958	1942	1941	1943	1931	1942	1941	1941	1941	1943	1941
	GREATEST 24-HOUR:	1.90	1.26	1.32	1.46	1.61	1.98	1.90	2.16	2.35	1.50	1.35	1.22	----
	YEAR:	1936	1940	1916	1942	1937	1913	1927	1939	1936	1928	1934	1938	----
	LEAST ANNUAL											IN 1946:		9.56
MOUNTAIN PARK	MONTHLY MEANS:	1.07	1.11	1.04	0.60	0.72	1.31	3.13	3.14	2.02	1.49	0.64	0.88	17.15
	GREATEST MONTHLY:	3.34	3.95	4.91	2.98	3.61	6.91	9.76	6.05	9.26	4.61	1.59	3.15	41.44
27	YEAR:	1949	1931	1958	1931	1940	1933	1955	1954	1941	1941	1944	1942	1941
	GREATEST 24-HOUR:	1.75	1.60	1.61	1.32	3.05	3.50	2.18	2.26	3.80	2.20	1.65	1.40	----
	YEAR:	1935	1931	1958	1942	1940	1933	1918	1921	1936	1928	1923	1942	----
	LEAST ANNUAL											IN 1934:		5.23
NEW MEXICO STATE UNIVERSITY	MONTHLY MEANS:	0.47	0.53	0.31	0.18	0.31	0.54	1.26	1.66	1.29	0.74	0.32	0.46	8.08
	GREATEST MONTHLY:	1.85	1.48	1.84	1.04	1.07	1.75	3.65	7.41	7.53	2.10	1.02	1.38	19.60
28	YEAR:	1949	1957	1958	1941	1935	1940	1938	1935	1941	1955	1936	1931	1941
	GREATEST 24-HOUR:	0.86	1.25	1.13	1.20	0.97	2.43	1.55	6.49	4.11	1.38	1.20	0.99	----
	YEAR:	1936	1893	1900	1905	1916	1903	1955	1935	1941	1928	1899	1931	----
	LEAST ANNUAL:											IN 1953:		3.81

TABLE III PRECIPITATION MEANS AND EXTREMES

STATION	DATA	JAN.	FEB.	MAR.	APR.	MAY.	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
OROGRANDE	MONTHLY MEANS:	0.51	0.42	0.30	0.36	0.44	0.84	1.44	1.59	1.33	0.94	0.32	0.42	8.91
	GREATEST MONTHLY:	1.80	1.40	1.65	1.92	1.92	5.95	7.19	4.15	6.55	2.70	1.60	1.35	18.43
26	YEAR:	1938	1940	1958	1942	1941	1943	1955	1931	1941	1945	1931	1943	1941
	GREATEST 24-HOUR:	1.10	1.25	1.29	1.40	1.40	2.02	3.50	3.80	1.35	2.06	1.10	0.94	----
	YEAR:	1938	1911	1905	1939	1936	1920	1926	1931	1927	1929	1931	1926	----
	LEAST ANNUAL:											In 1934:		2.93
RUIDOSO	MONTHLY MEANS:	1.07	1.10	1.57	0.68	0.88	1.76	4.60	4.21	2.11	1.27	0.65	1.37	21.37
	GREATEST MONTHLY:	2.52	2.61	4.58	3.49	2.42	3.75	10.86	7.37	5.15	3.24	1.70	3.35	27.95
15	YEAR:	1949	1948	1958	1942	1954	1944	1950	1942	1958	1957	1957	1942	1942
	GREATEST 24-HOUR:	0.68	1.25	1.49	1.29	1.78	3.75	2.85	2.23	1.48	1.20	1.27	1.39	----
	YEAR:	1943	1948	1955	1942	1954	1944	1946	1946	1944	1955	1951	1948	----
	LEAST ANNUAL:											In 1947:		14.50
TULAROSA	MONTHLY MEANS:	0.57	0.57	0.48	0.42	0.41	0.76	1.38	1.65	1.97	0.[illegible]1	0.42	0.59	10.[illegible]
	GREATEST MONTHLY:	1.94	1.73	2.59	1.03	1.62	4.00	4.52	3.79	9.82	[illegible].80	1.58	2.38	[illegible]
26	YEAR:	1936	1931	1956	1953	1940	1943	1950	1955	1941	1957	[illegible]	1947	1941
	GREATEST 24-HOUR:	1.00	2.00	1.44	1.20	1.10	2.00	1.80	2.51	4.75	1.90	1.5[illegible]	1.30	----
	YEAR:	[illegible]	1915	1958	1953	1940	1943	1925	1937	1941	1956	1947	1943	----
	LEAST ANNUAL:											In 1934:		3.88
WHITE SANDS NATIONAL MONUMENT	MONTHLY MEANS:	0.56	0.33	0.32	0.36	0.32	0.47	1.28	1.28	1.26	[illegible].38	0.2[illegible]	0.[illegible]	7.7[illegible]
	GREATEST MONTHLY:	2.[illegible]5	0.93	2.65	2.39	1.51	1.58	2.97	3.06	9.68	3.79	0.90	1.93	20.[illegible]
	YEAR:	1949	1948	1958	1942	1940	1943	1957	1948	1941	1957	1943	1947	[illegible]
30	GREATEST 24-HOUR:	[illegible].75	0.52	1.55	1.11	1.10	1.22	1.61	1.40	5.30	1.00	0.60	0.90	----
	YEAR:	1939	1948	1956	1942	1940	1943	1957	----	1941	1958	1939	1943	----
	LEAST ANNUAL:											In 1956:		2.8[illegible]
[illegible]	MONTHLY MEANS:	[illegible].45	0.41	0.35	0.27	0.35	0.64	1.72	1.54	1.19	0.64	0.45	0.50	[illegible]
	GREATEST MONTHLY:	1.84	1.88	2.26	2.24	1.92	2.62	4.93	4.39	6.29	4.31	2.50	[illegible]	[illegible]
54	YEAR:	1949	1905	1958	1931	1941	1938	1914	1917	1958	1945	1906	1914	[illegible]
	**GREATEST 24-HOUR:	0.60	0.87	1.72	0.89	1.23	1.13	1.28	2.00	2.0[illegible]	1.77	1.1[illegible]	1.05	----
	YEAR:	1949	1956	1941	1952	1941	1958	1957	1957	1941	1945	1943	1946	----
	LEAST ANNUAL:											In 1934:		[illegible]

**RECORD OF GREATEST 24-HOUR RAINFALL IS FROM 1940 to 1958 AT THE AIRPORT STATION.

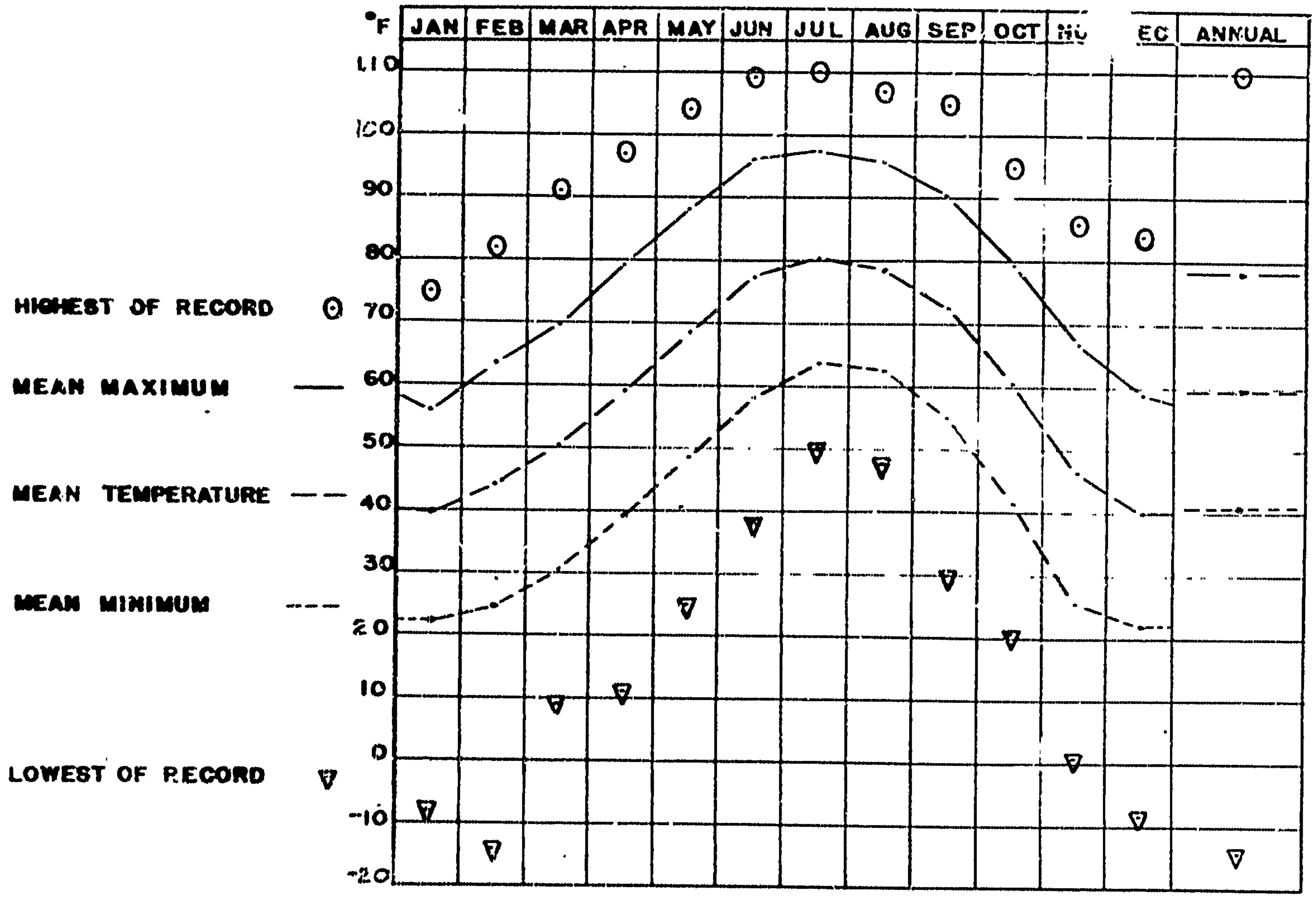


FIG. 5. TEMPERATURE MEANS AND EXTREMES, WHITE SANDS NATIONAL MONUMENT

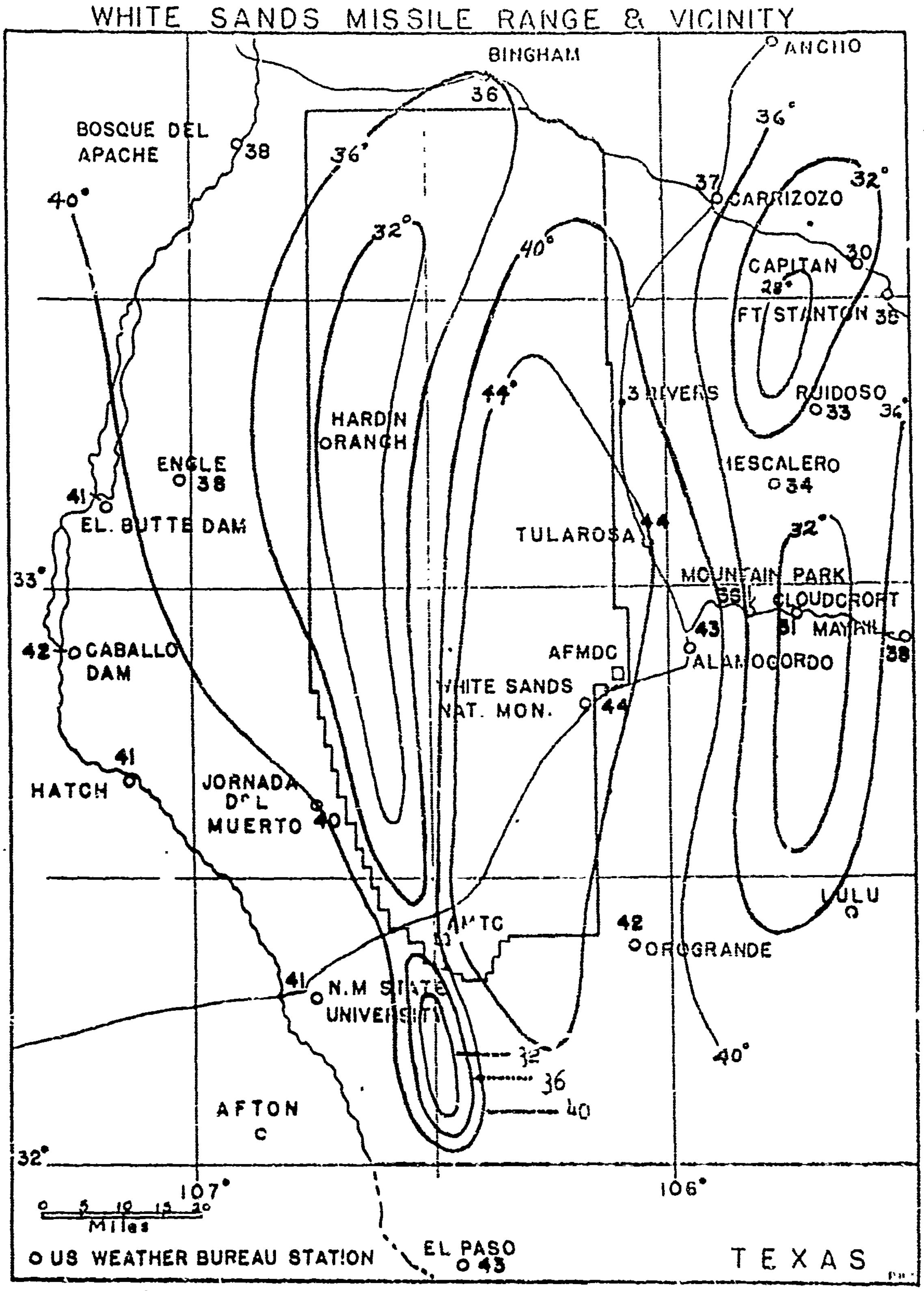


FIG. 6. MEAN TEMPERATURE: JANUARY – WSMR

WHITE SANDS MISSILE RANGE & VICINITY

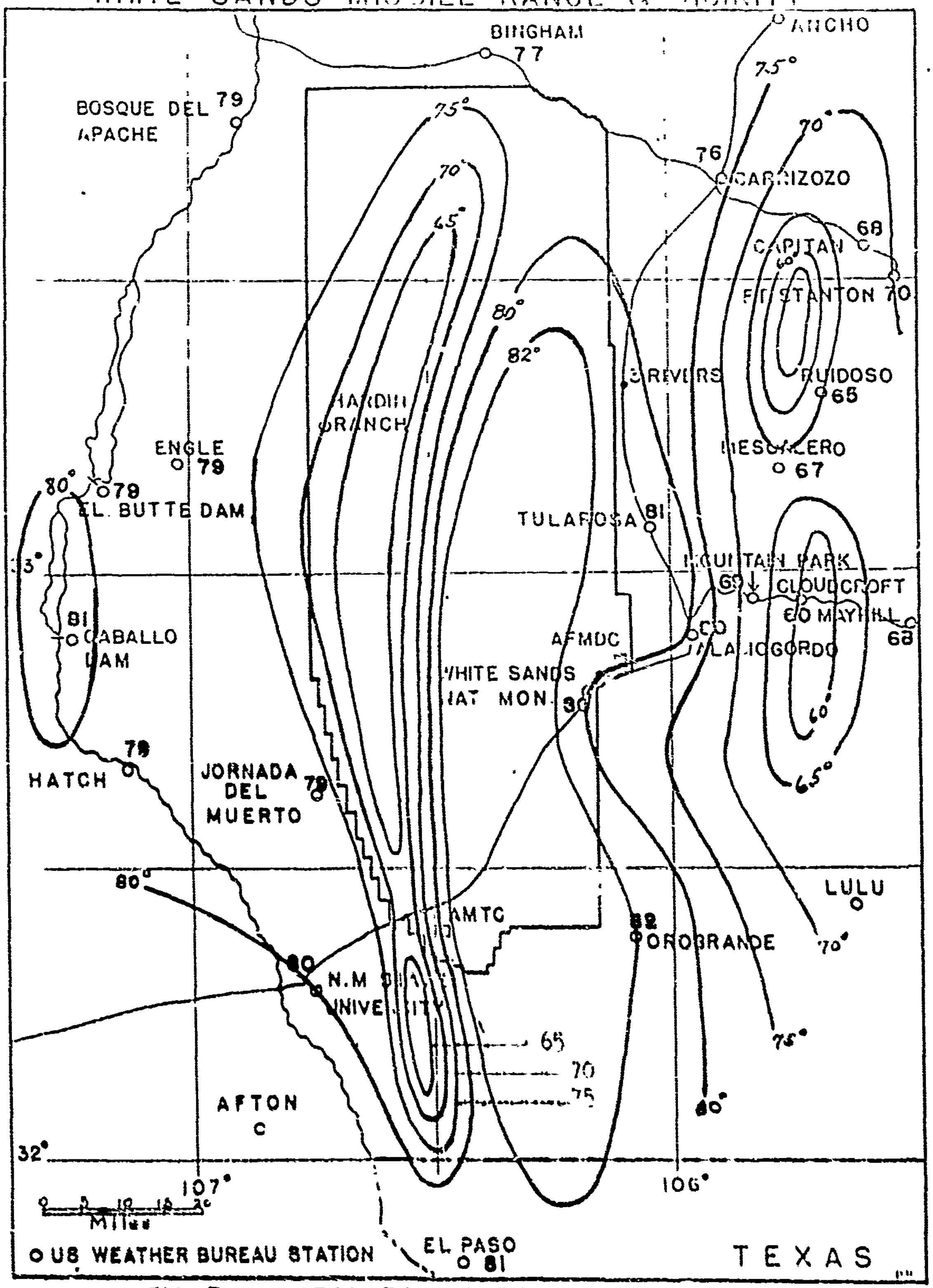


FIG. 7 MEAN TEMPERATURE: JULY-WSMR

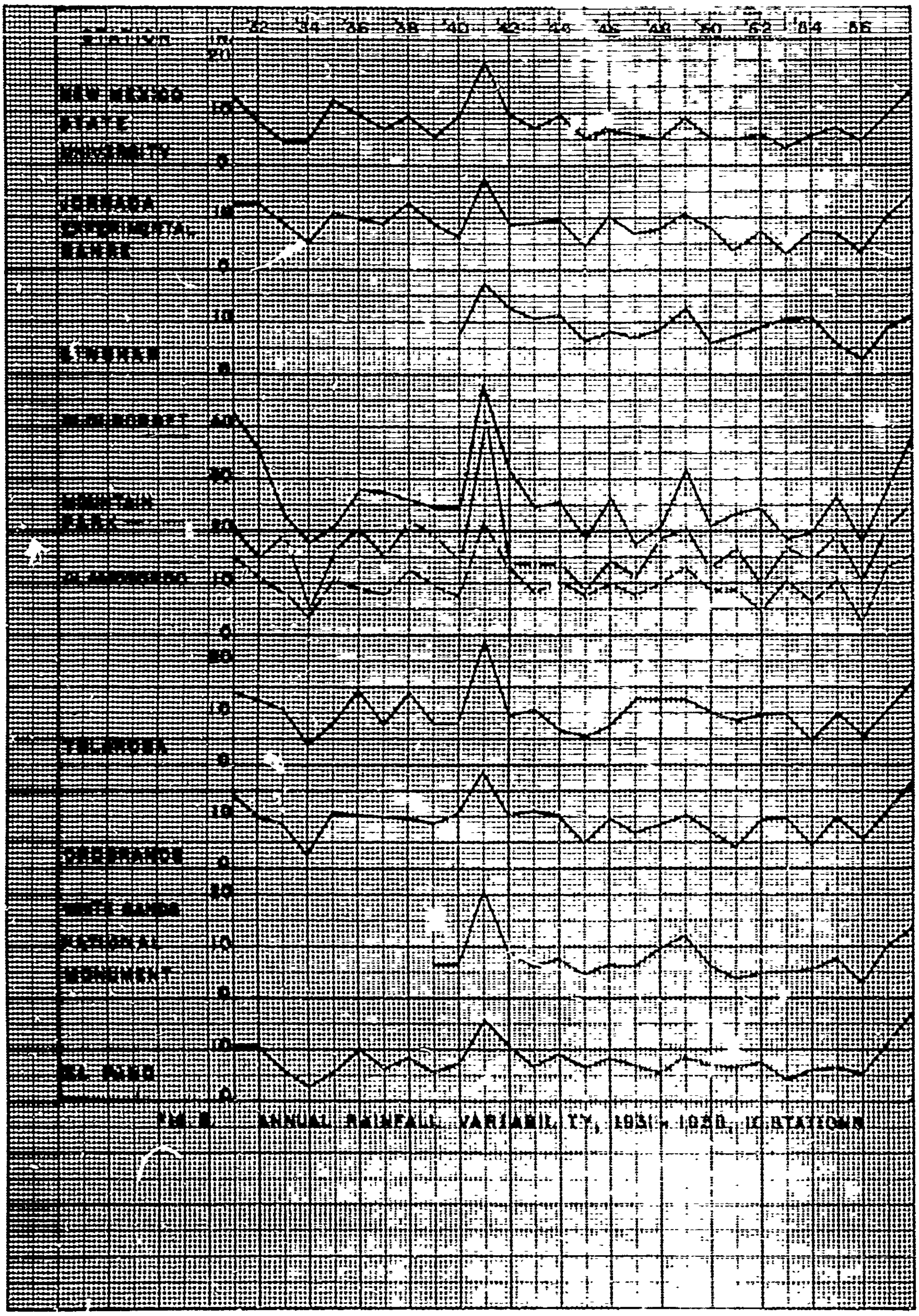


FIG. 8 ANNUAL RAINFALL VARIABILITY, 1931 - 1956, 10 STATIONS

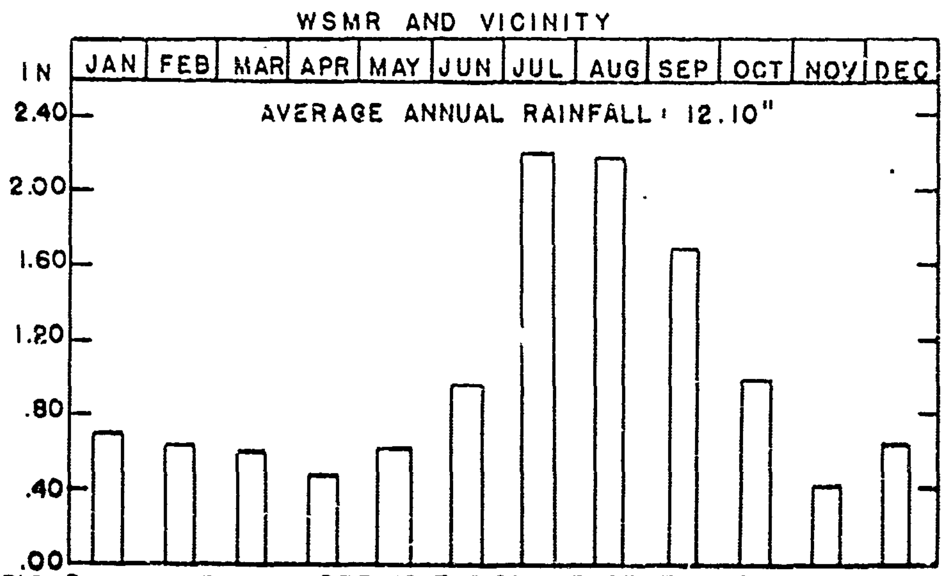
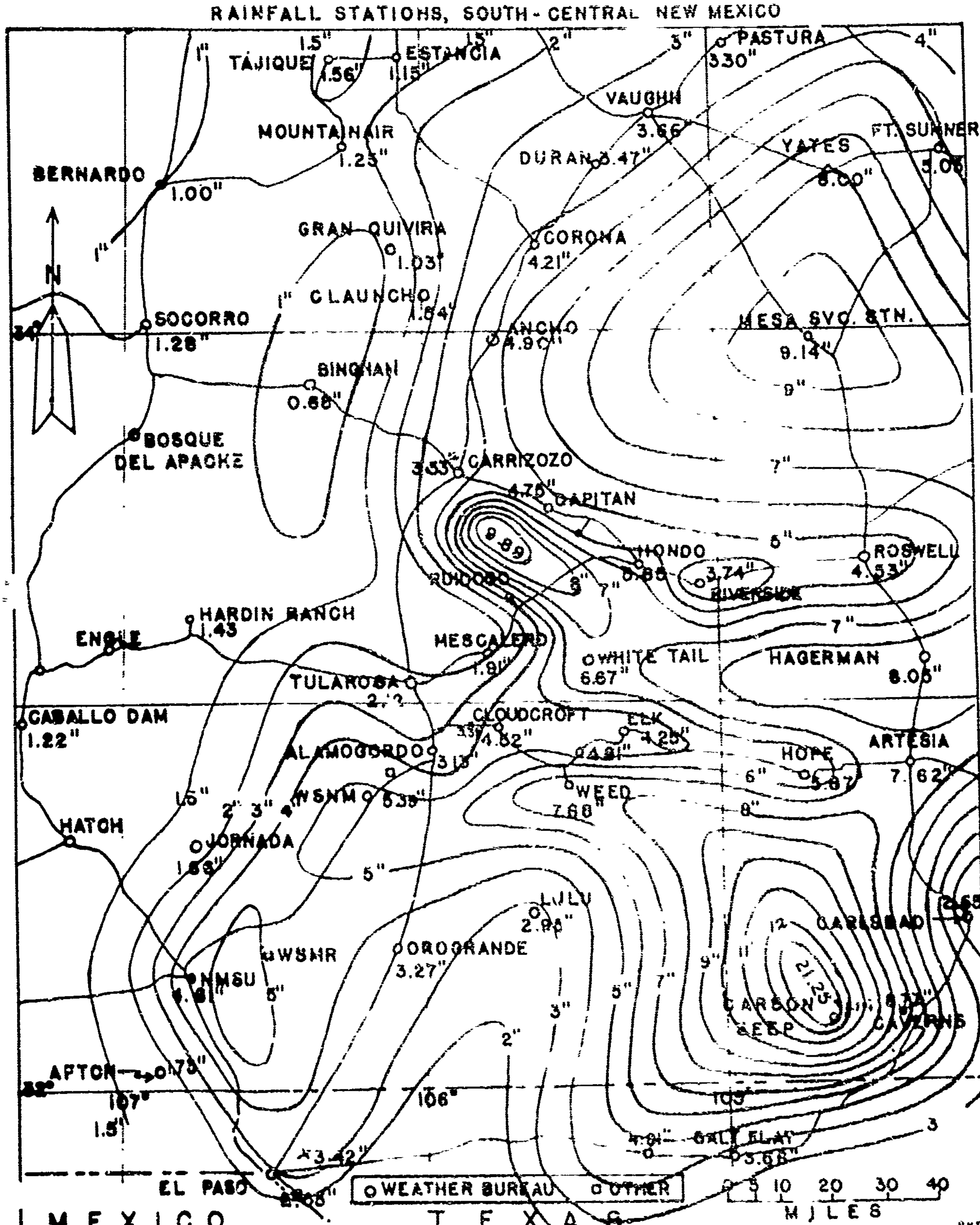


FIG. 9. AVERAGE PRECIPITATION, 25 STATIONS

RAINFALL STATIONS, SOUTH-CENTRAL NEW MEXICO



TOTAL RAINFALL, STORM OF SEPT. 20-24, 1941—(TOTALS FROM WEATHER BUREAU RECORDS)

FIG. 10.

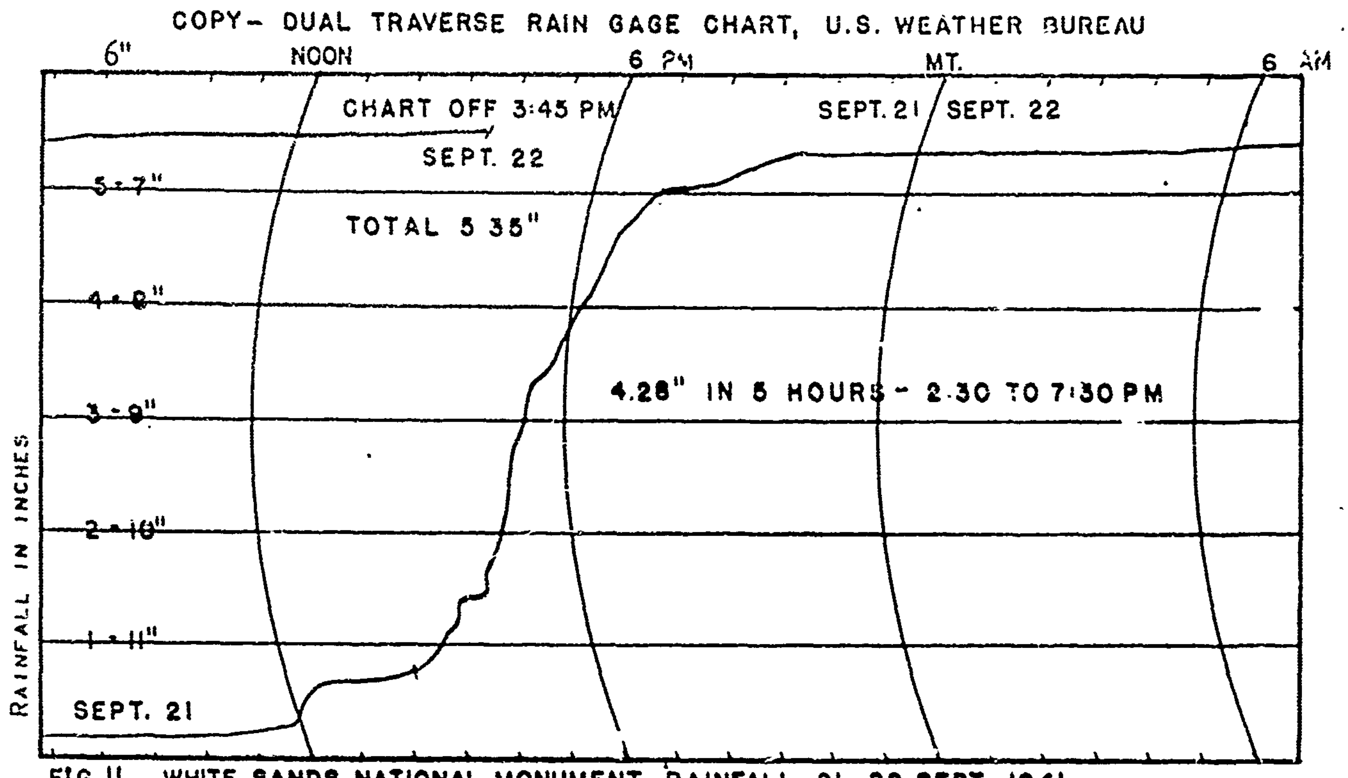


FIG. 11. WHITE SANDS NATIONAL MONUMENT RAINFALL, 21–22 SEPT., 1941

Precipitation during the winter months, though generally of little consequence in the basin, is sometimes considerable in the mountain areas, (Tables III and IV). The principal source of moisture during this season is the Pacific Ocean, the moisture being brought in by the westerly flow of that period and set off by the movement of cold fronts down from the north.

AVERAGE ANNUAL SNOWFALL

Snowfall at the lower elevations is generally light (Table IV), of infrequent occurrence, and melts rapidly. White Sands National Momument, a representative station for the basin, averages only 2.4 inches of snow per year. Hardin Ranch, at an elevation of 6,000 feet MSL and the only mountain station on the reservation, averages 19 inches per year. Snow at the mountain stations on the east side of the basin is considerably heavier, ranging from 25 inches at Mountain Park to 75 inches at Cloudcroft, and much of it remains on the ground for prolonged periods.

SEVERE LOCAL STORMS AND OTHER WEATHER ELEMENTS

Tornadoes are rare in this area, but two or three have been observed within the past few years. Thunderstorms are occasionally severe and have damaged communication lines on the range, and many local roads have been impassable for days or weeks at a time. For the ten-year period 1948-1957 at the Air Weather "A" Station, WSMR, (Table V) thunderstorms averaged 63 per year, with 53 of them occurring in the four months, June through September, and 43 in July and August.

Tabulated summaries for Air Weather "A" Station for temperature, precipitation, snowfall, thunderstorms, cloudiness, relative humidity, and visibility are included in Table V. These data were obtained from "Climatic Data for the White Sands Missile Area," October, 1958, compiled by Detachment 24, 4th Weather Group, White Sands Missile Range.

TABLE IV AVERAGE SNOWFALL

STATION	YEARS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
AFTON	8	5.0	0.5	0.5	0	T	0*	T*	0*	0	0	0.9	0.5	7.5
ALAMOGORDO	49	1.9	1.2	0.6	0.1	T	0	0	0	0	T	0.3	1.1	5.2
ANCHO	20	8.8	5.9	5.4	3.4	1.0	T	0	T	0.4	0	2.7	5.1	32.7
BINGHAM	12	3.2	0.9	0.9	1.1	T	T	0	0	T	0	0.6	2.2	8.9
BOSQUE DEL APACHE	54	1.3	0.6	0.7	0.1	0	0	T	0	T	T	0.6	2.2	5.5
CABALLO DAM	13	0.5	0.5	0.1	0	T	0	0	0	0	0	0.1	0.2	1.4
CAPITAN	39	7.6	7.6	5.5	2.3	0.5	T	T	T	0.4	0.6	2.1	7.0	35.5
CARRIZOZO	20	3.8	2.8	2.2	1.0	T	0	T	T	T	0	1.1	2.4	13.4
CLOUDCROFT	47	15.6	15.3	13.7	5.2	1.3	T	T	T	0.2	2.1	7.7	13.8	74.9
ENGLE	20	1.5	0.5	0.2	T	T	0.1	0	0	T	0	0.3	0.8	3.4
FT. STANTON	51	4.7	4.9	3.5	1.1	0.1	T	T	0	0.1	0.5	2.1	4.1	21.1
HARDIN RANCH	8	10.9	0.9	1.7	1.3	0	0	0	0	0	0	1.5	2.7	19.0
HATCH	21	1.4	0.2	0.1	0	0	0	0	0	0	0	T	0.7	2.[illegible]
JORNADA DEL MUERTO	31	1.2	0.1	0.1	0.1	0	T	0	0	0	T	0.3	0.7	2.[illegible]
MAYHILL RANGER STN.	22	8.4	5.6	5.7	1.7	0.3	T	T	T	0.3	0.4	2.9	6.3	[illegible]
MESCALERO	35	5.2	5.9	5.3	1.1	0.2	0	0	0	0.2	0.3	2.0	5.7	[illegible]
MOUNTAIN PARK	34	5.9	5.8	4.4	1.2	0.2	T	0	T	0.1	0.3	2.3	5.2	[illegible]
N.M. STATE UNIVERSITY	52	0.5	0.3	0.3	T	0	0	0	0	0	0	0.4	0.9	[illegible]
OROGRANDE	41	1.2	0.4	0.3	T	0	0	0	0	0	T	0.2	1.2	[illegible]
RUIDOSO	9	12.6	6.7	9.4	4.7	0.3	T	T	T	0.3	0.1	3.9	11.0	49.0
TULAROSA	40	1.7	0.8	0.8	0.1	T	0	0	0	0	T	0.5	1.0	[illegible]
WHITE SANDS NAT. MON.	11	1.5	T	0.1	T	T	T	0	0	0	0	T	0.8	[illegible]
EL PASO AIRPORT (USWB)	19	1.7	0.6	0.6	T	0	0	0	0	0	0	0.5	0.7	[illegible]

* Snowfall records prior to 1956 included hail.

TABLE V AIR WEATHER STATION "A", WHITE SANDS MISSILE RANGE

DATA	JAN.	FEB.	MAR.	APR.	MAY.	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
TEMPERATURE MEANS AND EXTREMES, 1948 TO 1957													
MONTHLY MEANS:	45.7	48.5	54.8	64.7	71.9	81.7	81.6	80.7	76.1	65.9	52.2	45.5	63.5
HIGHEST:	73	77	83	94	103	107	107	101	103	91	85	73	107
LOWEST:	4	8	20	32	38	54	58	60	50	34	20	8	4
AVERAGE PRECIPITATION, 1948 TO 1957													
MONTHLY MEANS:	0.55	0.63	0.40	0.35	0.32	0.40	1.67	1.14	0.70	1.02	0.10	0.77	8.05
AVERAGE SNOWFALL, 1948 TO 1957													
MONTHLY MEANS:	1.4	1.3	0.1	T	T	0	T	0	0	0	0.1	[illegible]	4.3
TOTAL NUMBER OF THUNDERSTORMS, 1948 TO 1957													
TOTALS:	2	4	5	15	50	67	225	193	40	28	0	2	631
TENTHS OF SKY COVER, 1948 TO 1957													
AVERAGES:	4.1	3.5	4.0	3.5	3.1	3.1	5.0	4.2	2.4	2.5	2.3	3.4	3.4
RELATIVE HUMIDITY AT 1400M, 1948 TO 1955													
AVERAGES:	37%	25%	22%	18%	22%	27%	34%	34%	19%	22%	39%	37%	[illegible]
PERCENTAGE OF VISIBILITY FREQUENCIES, 1948 TO 1955													
0 to 2½ MILES:	2	1	2	1	0	0	0	0	0	0	0	1	1
3 to 6 MILES:	2	4	5	3	1	1	1	0	1	1	1	3	2
7 to 9 MILES:	1	2	3	3	2	1	1	1	1	1	1	1	1
10 MILES OR MORE:	95	93	90	93	97	98	98	99	98	98	98	95	96

REFERENCES

1. U. S. WEATHER BUREAU, "CLIMATIC SUMMARY OF NEW MEXICO, 1931-1952," NATIONAL WEATHER RECORDS CENTER, U. S. WEATHER BUREAU, ASHEVILLE, N. C., 1956.

2. CASTETTER, EDWARD F., "THE VEGETATION OF NEW MEXICO," NEW MEXICO QUARTERLY, VOL XXVI, NO. 3, UNIVERSITY OF NEW MEXICO, ALBUQUERQUE, N. M., 1956.

3. HOIDALE, GLENN B., "SLOPE-VALLEY WINDS AT WHITE SANDS MISSILE RANGE, N.M.," SPECIAL REPORT 21, MISSILE GEOPHYSICS DIVISION, USA SMSA, WHITE SANDS MISSILE RANGE, N.M., OCTOBER 1959.

4. U. S. WEATHER BUREAU, "PERCENTAGE FREQUENCY OF OCCURRENCE, WHITE SANDS PROVING GROUND, NEW MEXICO," PERIOD 1947-1955, NATIONAL WEATHER RECORDS CENTER, U. S. WEATHER BUREAU, ASHEVILLE, N. C., 1956.

5. U. S. WEATHER BUREAU, "SPECIAL SUMMARIES, EL PASO, TEXAS, WBAS," PERIOD 1950 THROUGH 1955, NATIONAL WEATHER RECORDS CENTER, U. S WEATHER BUREAU, ASHVILLE, N. C. 1956.

6. BERRY, JAMES R., "SUMMARY OF WEATHER OBSERVATIONS AT HOLLOMAN AIR FORCE BASE." HOLLOMAN AIR DEVELOPMENT CENTER TECHNICAL REPORT HADC TR57-2, AD NO. 113033, HOLLOMAN AIR DEVELOPMENT CENTER, ALAMOGORDO, N. M., 1957.

7. U. S. WEATHER BUREAU, "SUPPLEMENTAL BULLETIN, SOUTHWEST DISTRICT," U. S. WEATHER BUREAU HYDROLOGIC OFFICE, ALBUQUERQUE, N. M., SEPT. 1941.

BIBLIOGRAPHY

Byers, Horace R., "General Meteorology," McGraw Hill Book Co., New York, N. Y., 1944.

Charles, Tom, "Story of the Great White Sands," (Publisher not given), Alamogordo, N. M., 1955.

Flora, Snowden D.. "Tornadoes of the United States," University of Oklahoma Press, Norman, Okla., 1953.

Haurwitz and Austin, "Climatology," McGraw-Hill Book Co., New York, N. Y., 1944.

Holmboe, Jorgen and Harold Klieforth, "Final Report, Sierra Wave Project," Dept. of Meteorology, University of Southern California at Los Angeles, Los Angles, Calif., 1954.

Humphreys, W. J., "Physics of the Air," McGraw-Hill Book Co., New York, N. Y., 1940.

Landsberg, Helmut, "Physical Climatology," Penn State College, State College, Penn., 1950.

Sutcliffe, R. C., "Meteorology for Aviators," Chemical Publishing Co., Brooklyn, N. Y., 1940.

U. S. Weather Bureau, "Climatological Data," 1953 through 1958, National Weather Records Center, U. S. Weather Bureau, Asheville, N. C. (Annual Publications).

APPENDIX A

GRAPHICAL PRESENTATION OF SURFACE WIND DATA

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PERCENTAGE FREQUENCY OF OCCURRENCE BY SPEED GROUPS

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A-2. SURFACE WINDS - 13 TO 46 MILES PER HOUR
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A-3. SURFACE WINDS - CALM TO 16 MILES PER HOUR
HOLLOMAN AIR DEVELOPMENT CENTER -------------------------- 33

A-4. SURFACE WINDS - 17 TO GREATER THAN 29 MILES PER HOUR
HOLLOMAN AIR DEVELOPMENT CENTER -------------------------- 34

A-5. SURFACE WINDS - 0 TO 24 MILES PER HOUR
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WIND SPEED AND DIRECTION VS TIME

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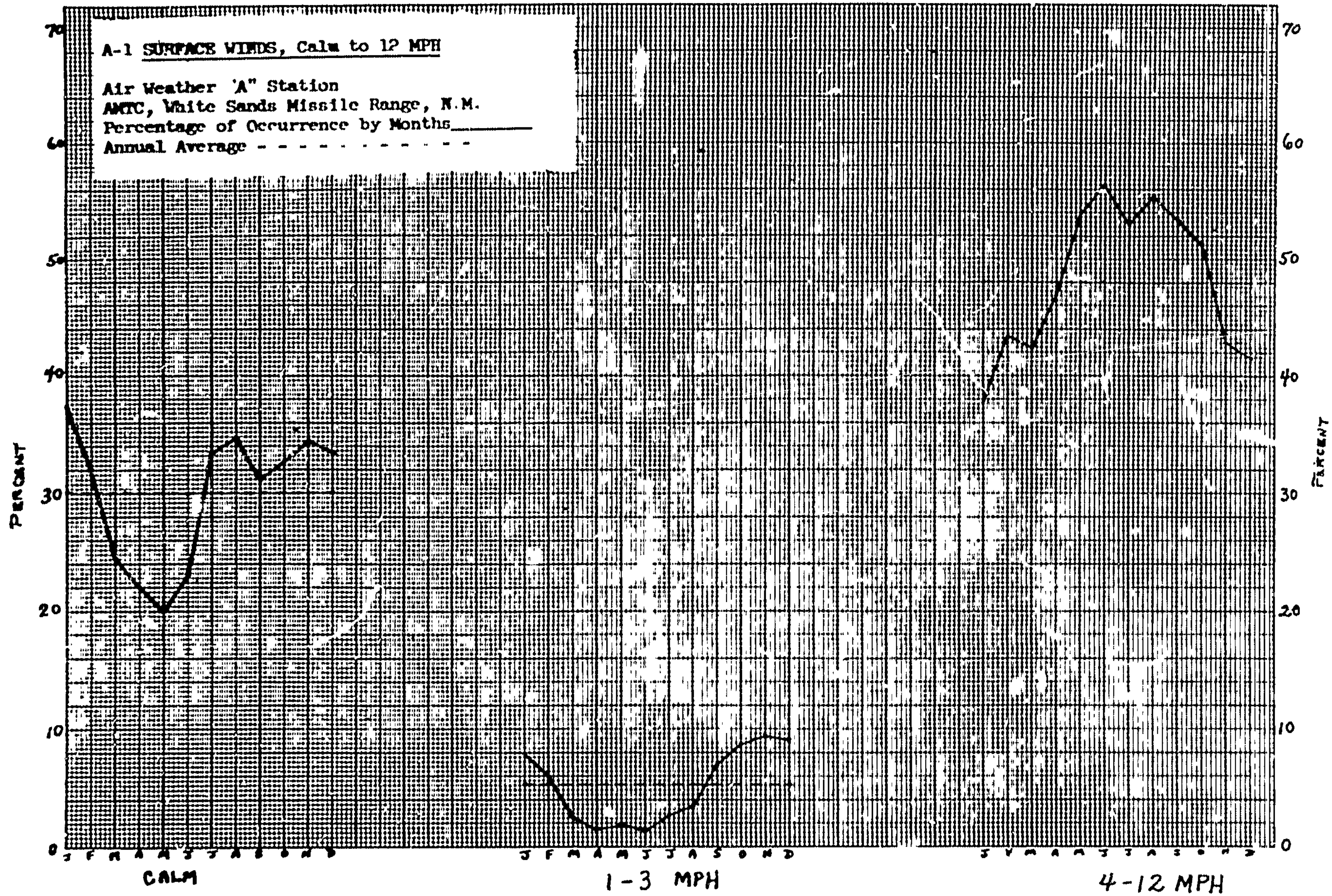
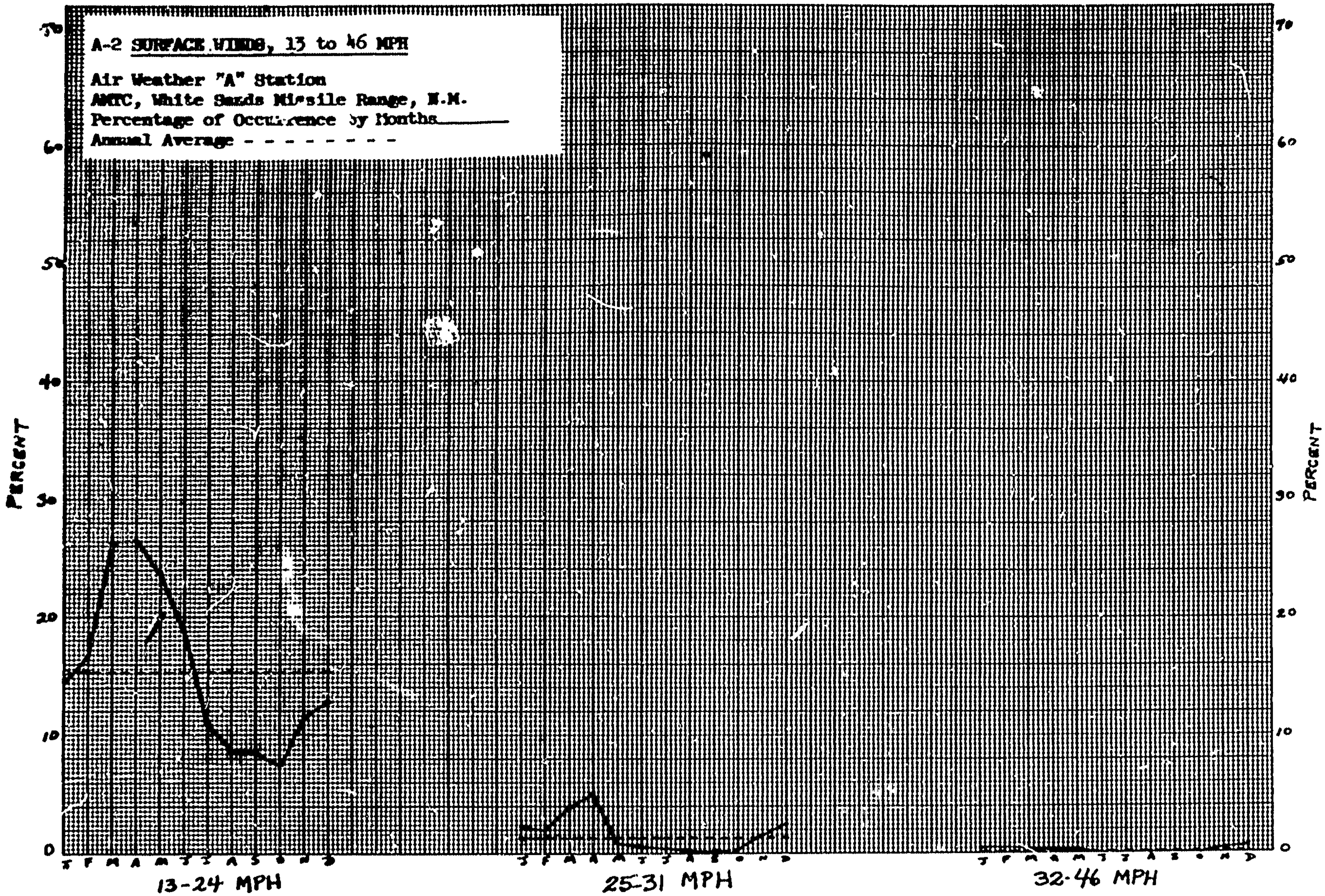
A-49. SURFACE WIND VARIABILITY, SR VAN, OSCURA, AND TULA SITES -- 79

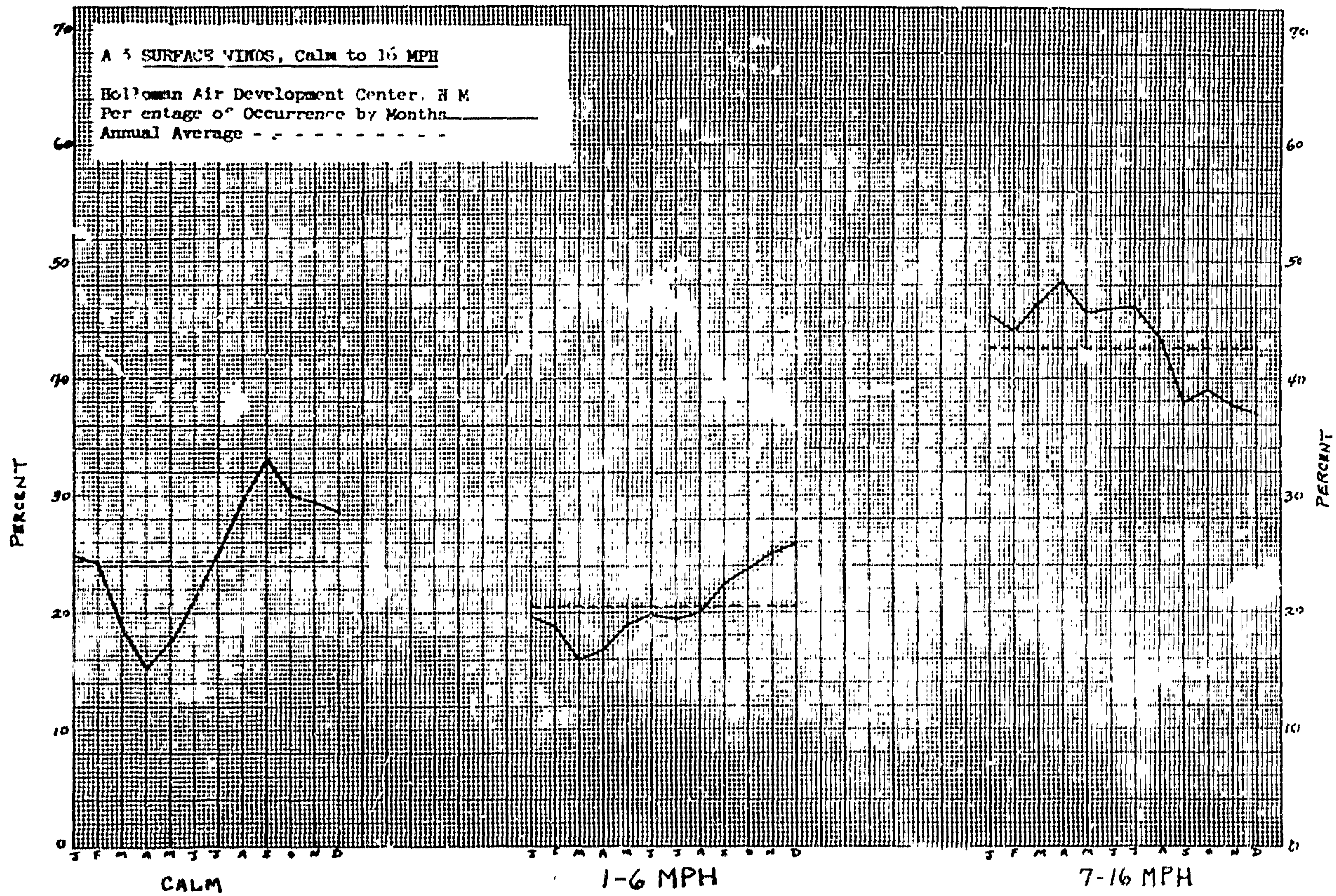
A-50. SURFACE WIND VARIABILITY, SR VAN, OSCURA, NW30, AND TULA SITES -- 80

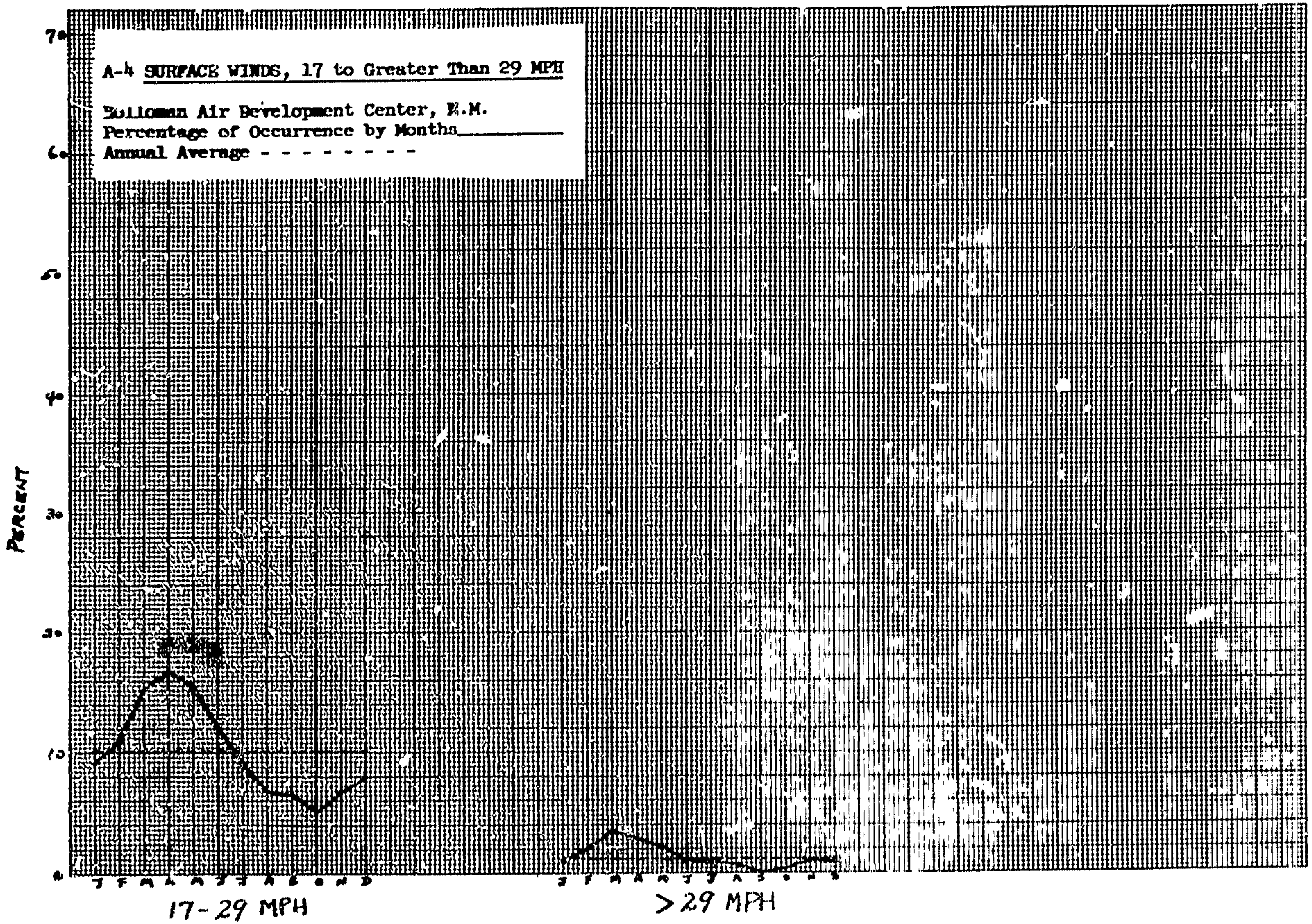
A-51. SURFACE WIND VARIABILITY, SR VAN, OSCURA, AND TULA SITES -- 81

A-52. SURFACE WIND VARIABILITY, SR VAN AND NW 30 SITES ---- 82


A-1 SURFACE WINDS, Calm to 12 MPH
Air Weather 'A" Station
AMTC, White Sands Missile Range, N.M.
Percentage of Occurrence by Months
Annual Average
PERCENT
0
10
20
30
40
50
60
70
J F M A M J J A S O N D
CALM
1-3 MPH
4-12 MPH

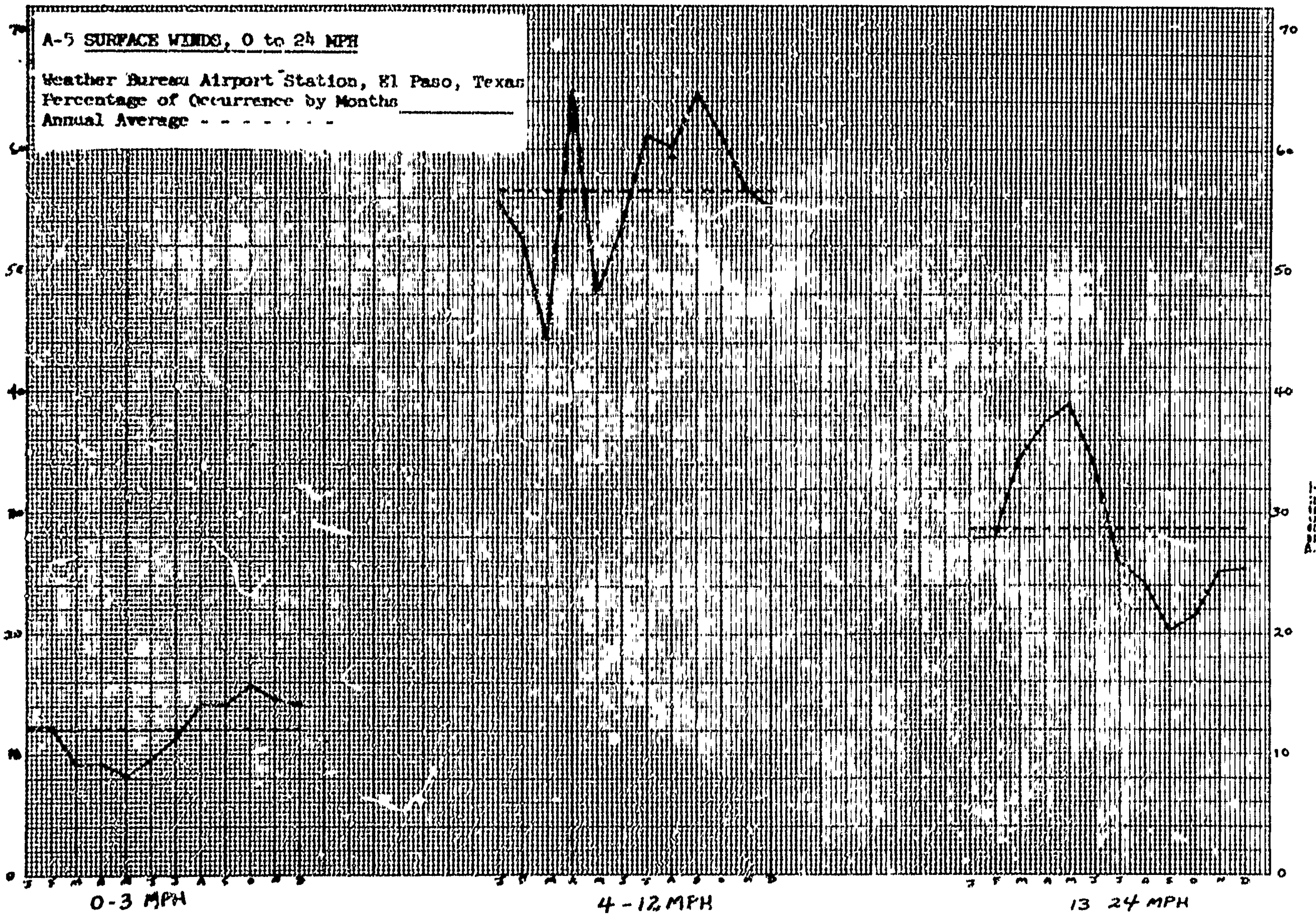

A-2 SURFACE WINDS, 13 to 46 MPH
Air Weather "A" Station
AMTC, White Sands Missile Range, N.M.
Percentage of Occurrence by Months
Annual Average - - - - - - - -
PERCENT
0
10
20
30
40
50
60
70
J F M A M J J A S O N D
13-24 MPH
25-31 MPH
32-46 MPH


A 3 SURFACE WINDS, Calm to 16 MPH
Holloman Air Development Center, N M
Percentage of Occurrence by Months
Annual Average
PERCENT
0
10
20
30
40
50
60
70
J F M A M J J A S O N D
CALM
1-6 MPH
7-16 MPH



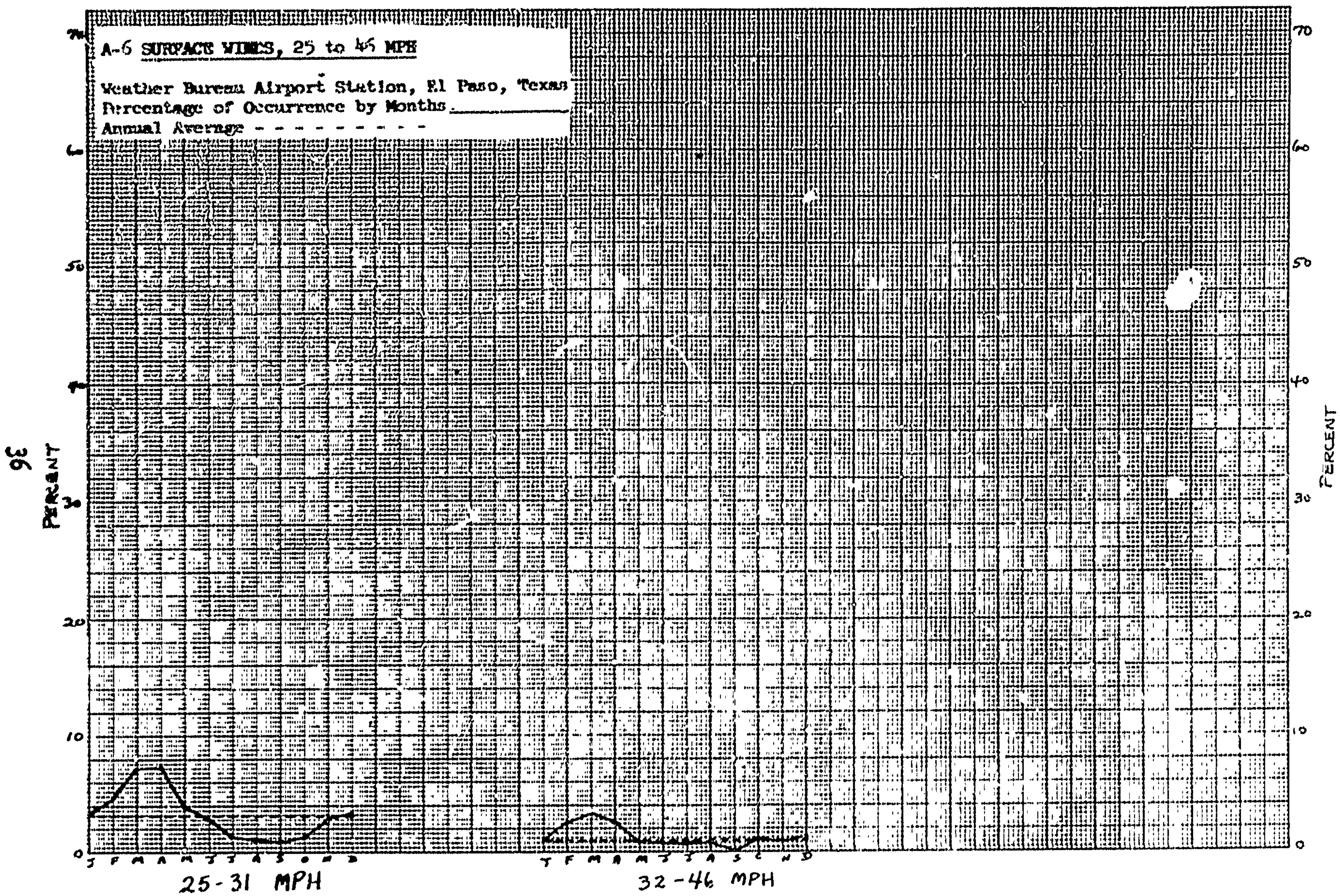
A-4 SURFACE WINDS, 17 to Greater Than 29 MPH

Holloman Air Development Center, N.M.
Percentage of Occurrence by Months ________
Annual Average - - - - - - - -

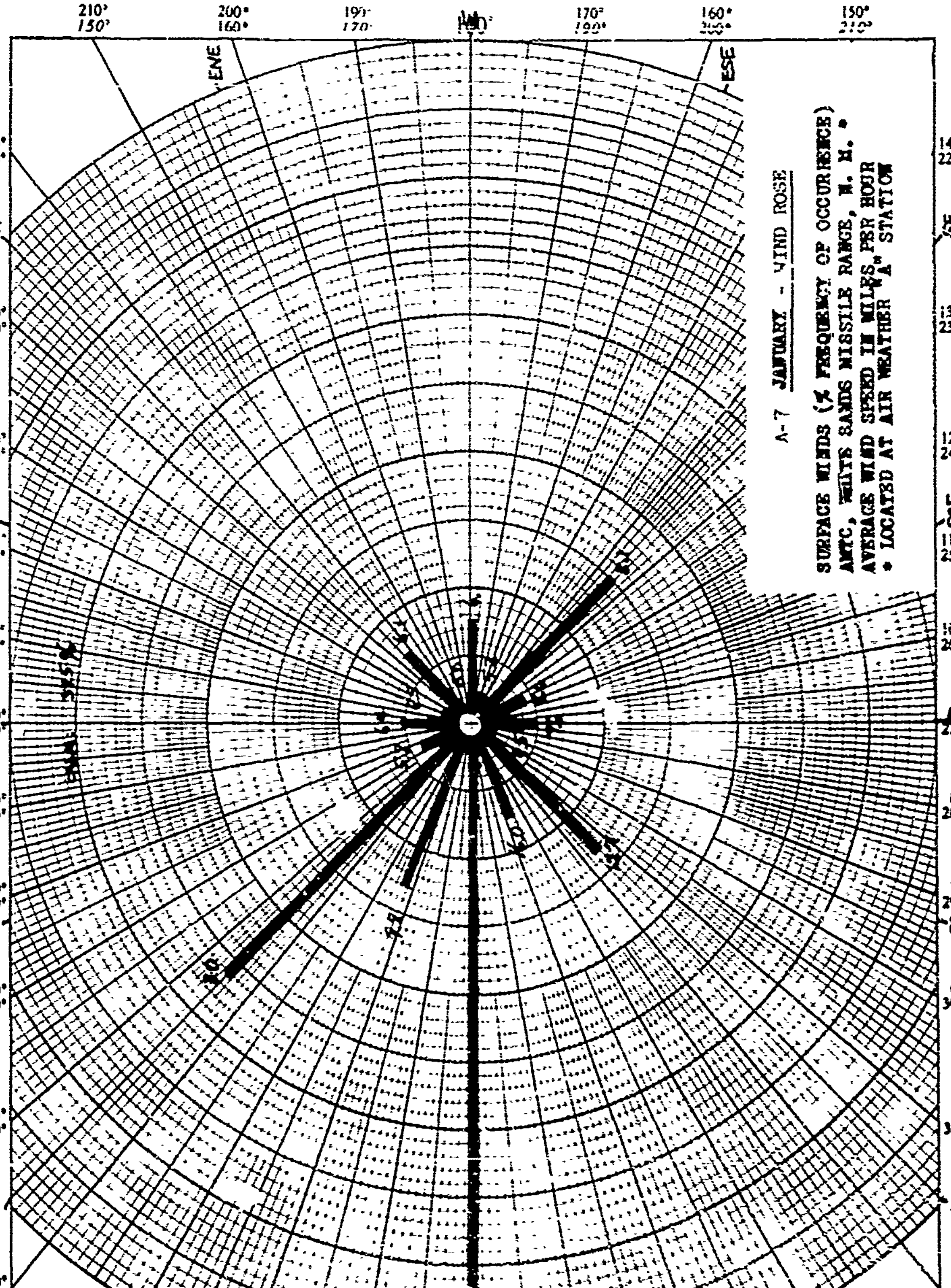


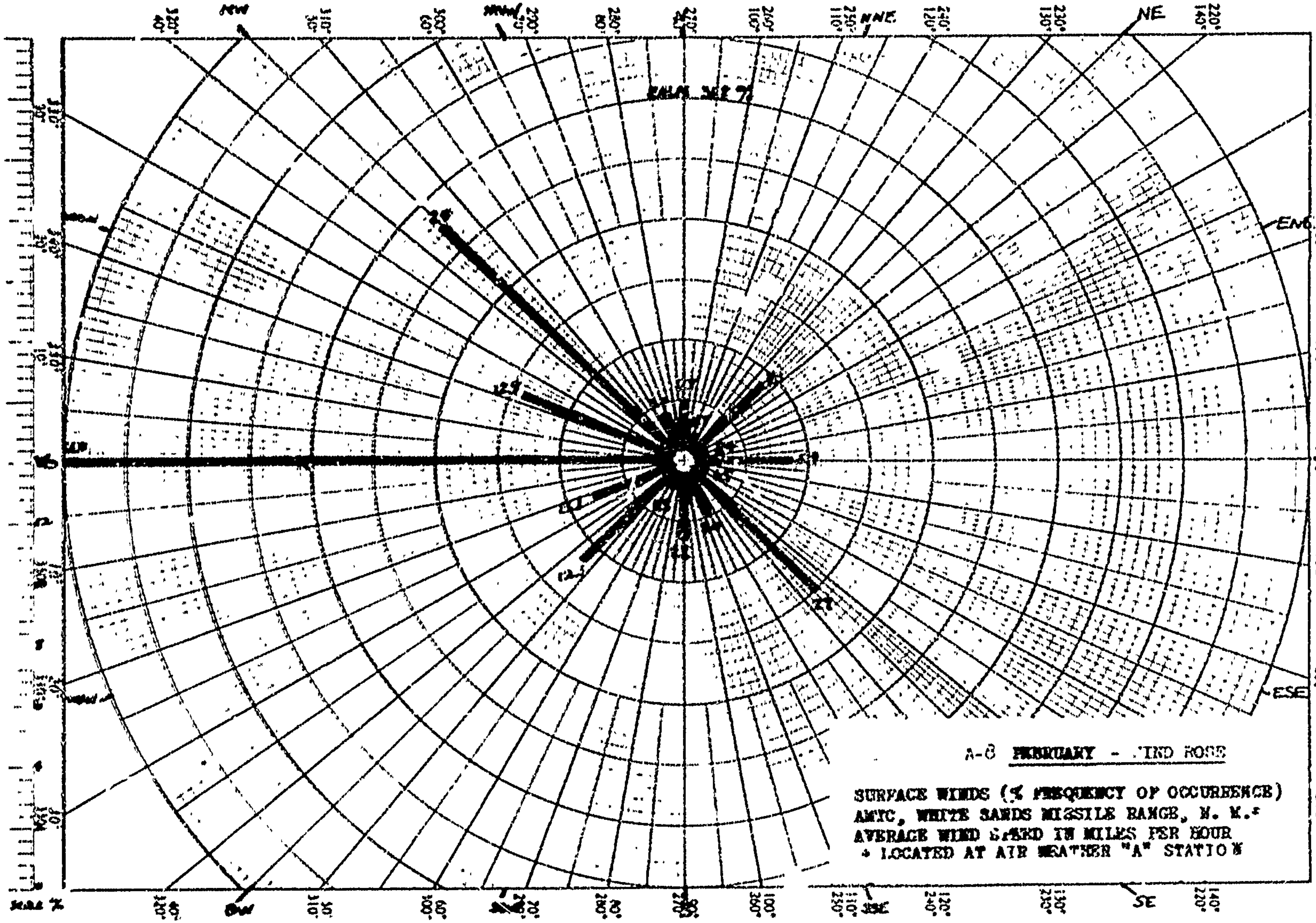
A-5 SURFACE WINDS, 0 to 24 MPH

Weather Bureau Airport Station, El Paso, Texas
Percentage of Occurrence by Months ______
Annual Average - - - - - - -



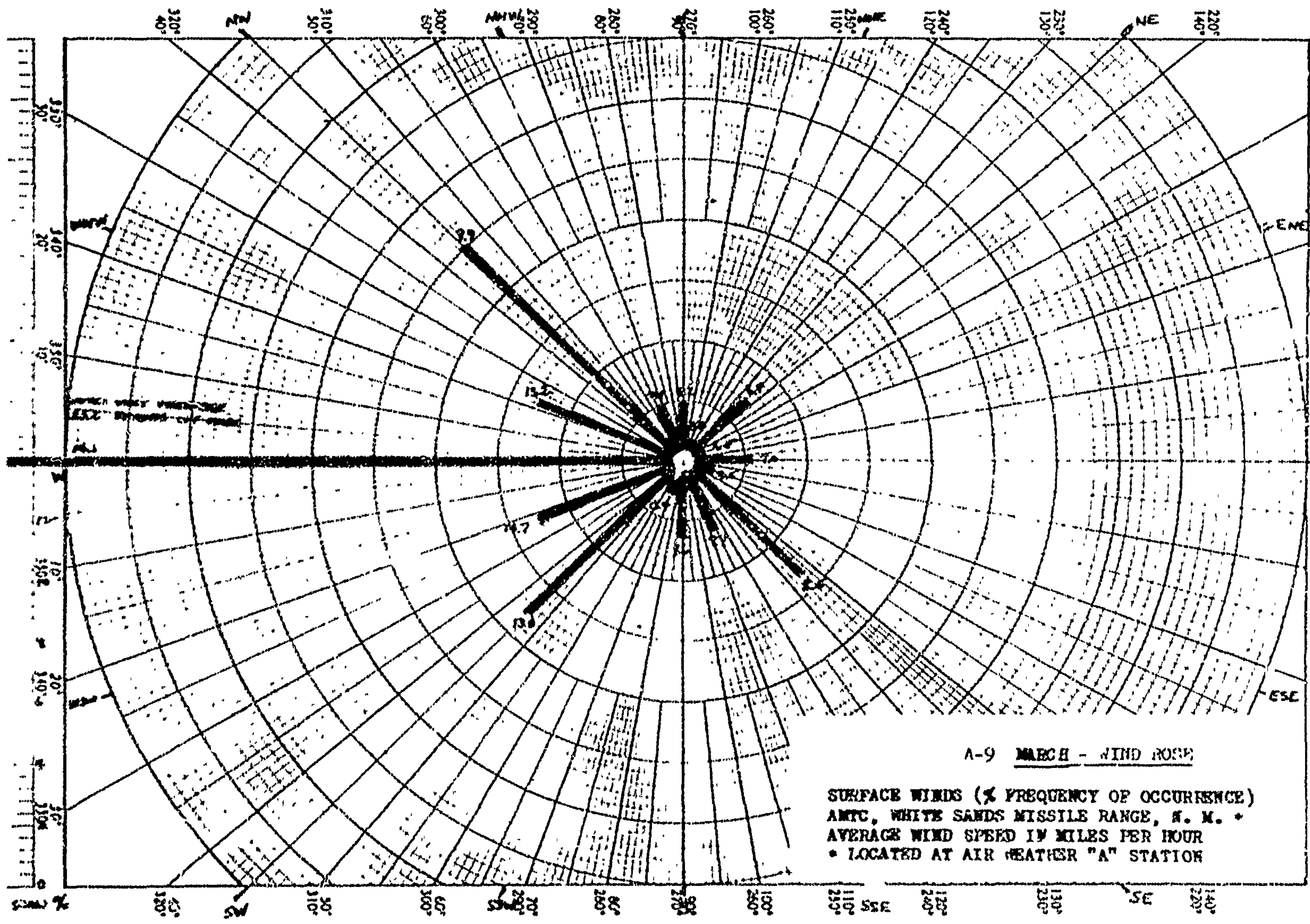
A-6 SURFACE WINDS, 25 to 45 MPH
Weather Bureau Airport Station, El Paso, Texas
Percentage of Occurrence by Months
Annual Average
PERCENT
0
10
20
30
40
50
60
70
J F M A M J J A S O N D
25-31 MPH
32-46 MPH


A-7 JANUARY - WIND ROSE
SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M. *
AVERAGE WIND SPEED IN MILES PER HOUR
* LOCATED AT AIR WEATHER "A" STATION



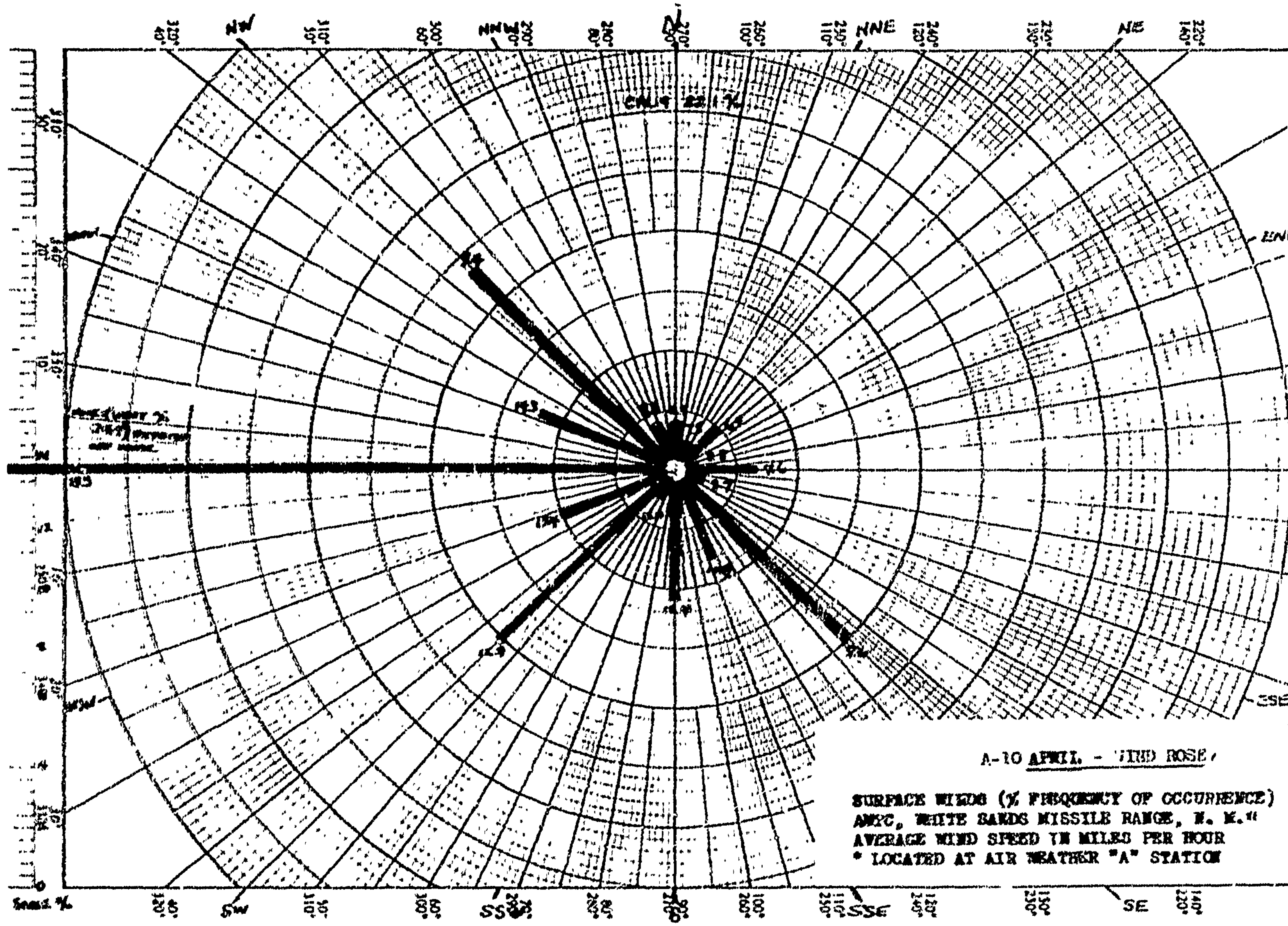
A-8 FEBRUARY - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
* LOCATED AT AIR WEATHER "A" STATION



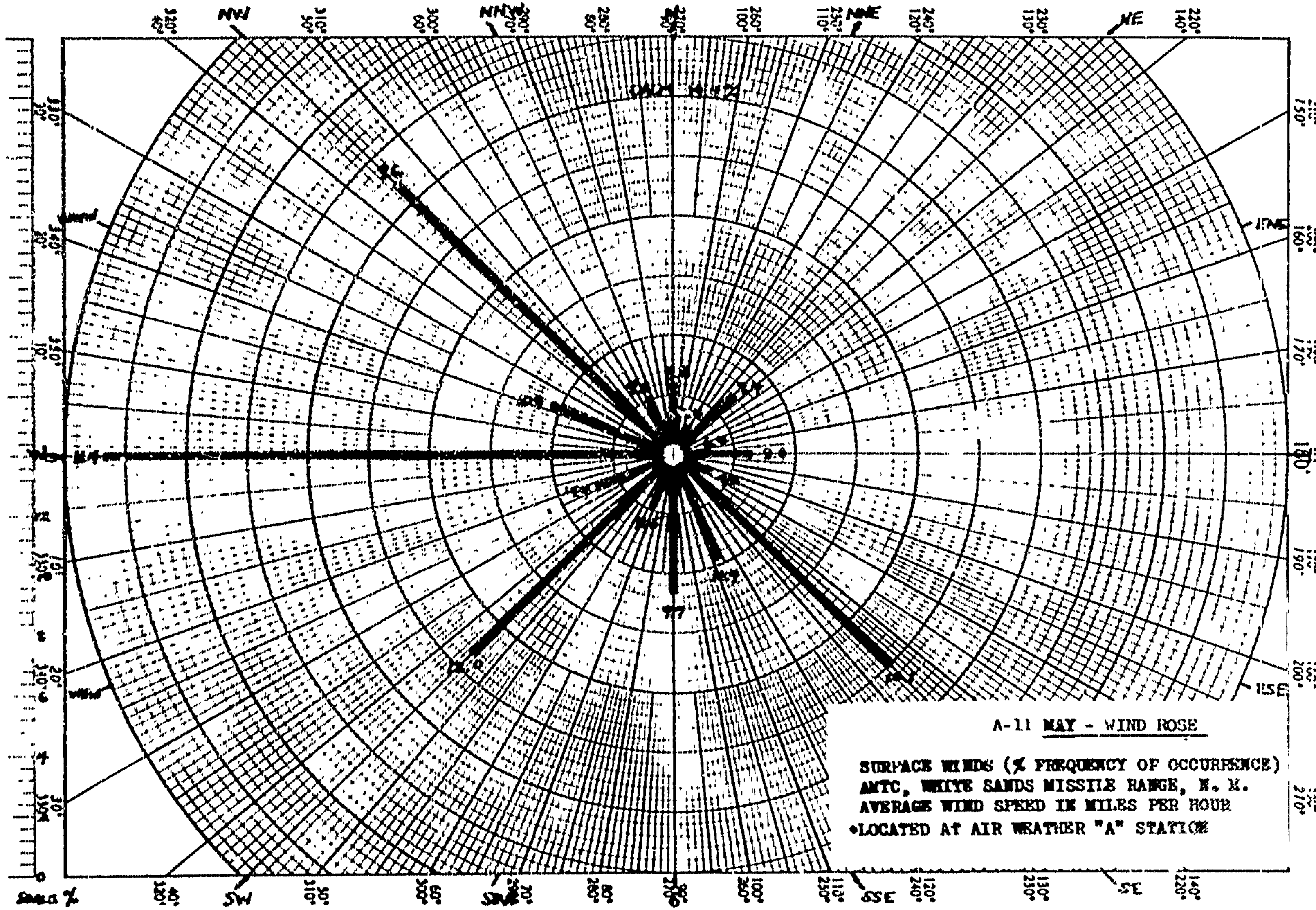
A-9 **MARCH** - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M. *
AVERAGE WIND SPEED IN MILES PER HOUR
* LOCATED AT AIR WEATHER "A" STATION



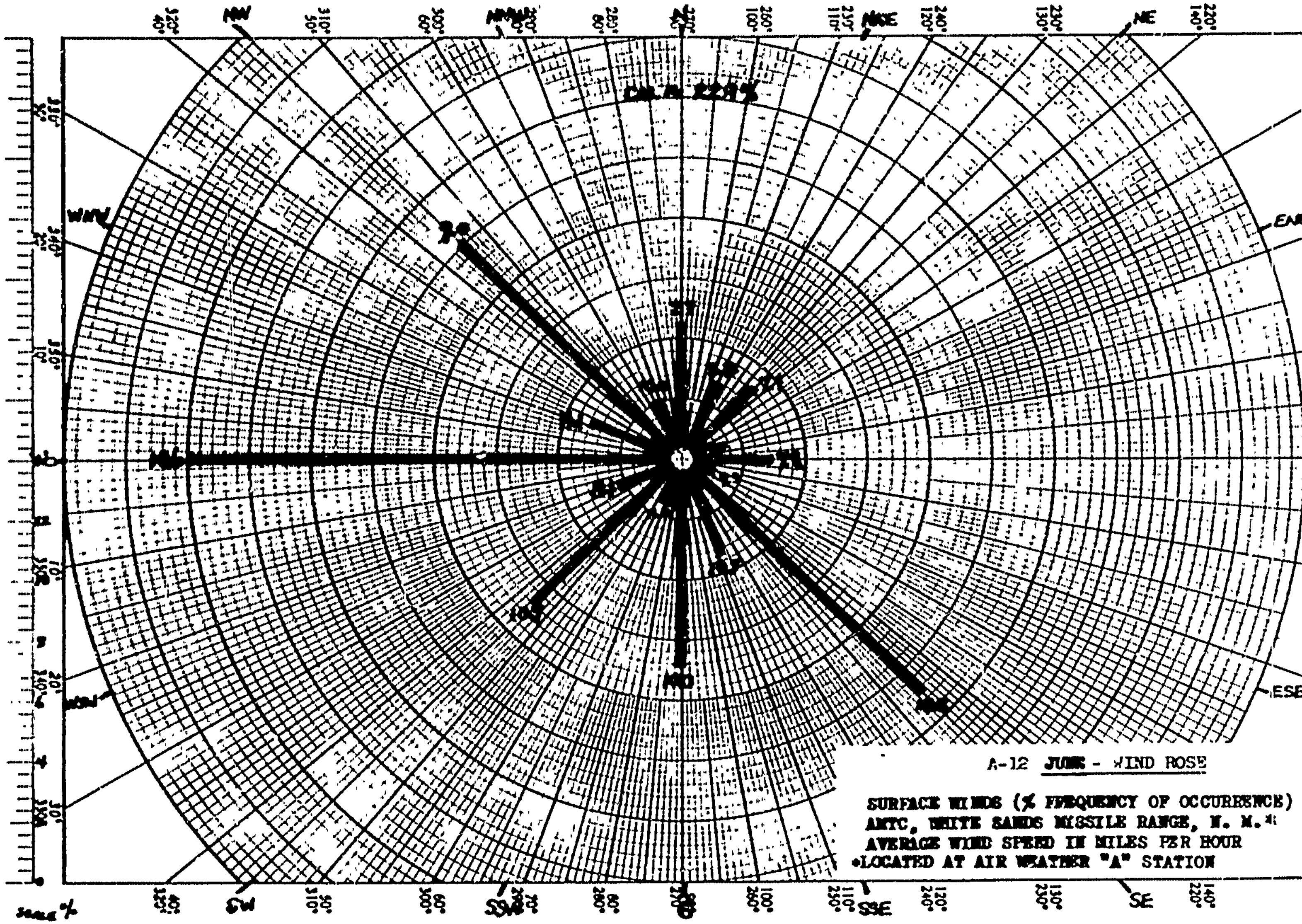
A-10 APRIL - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMPC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
* LOCATED AT AIR WEATHER "A" STATION



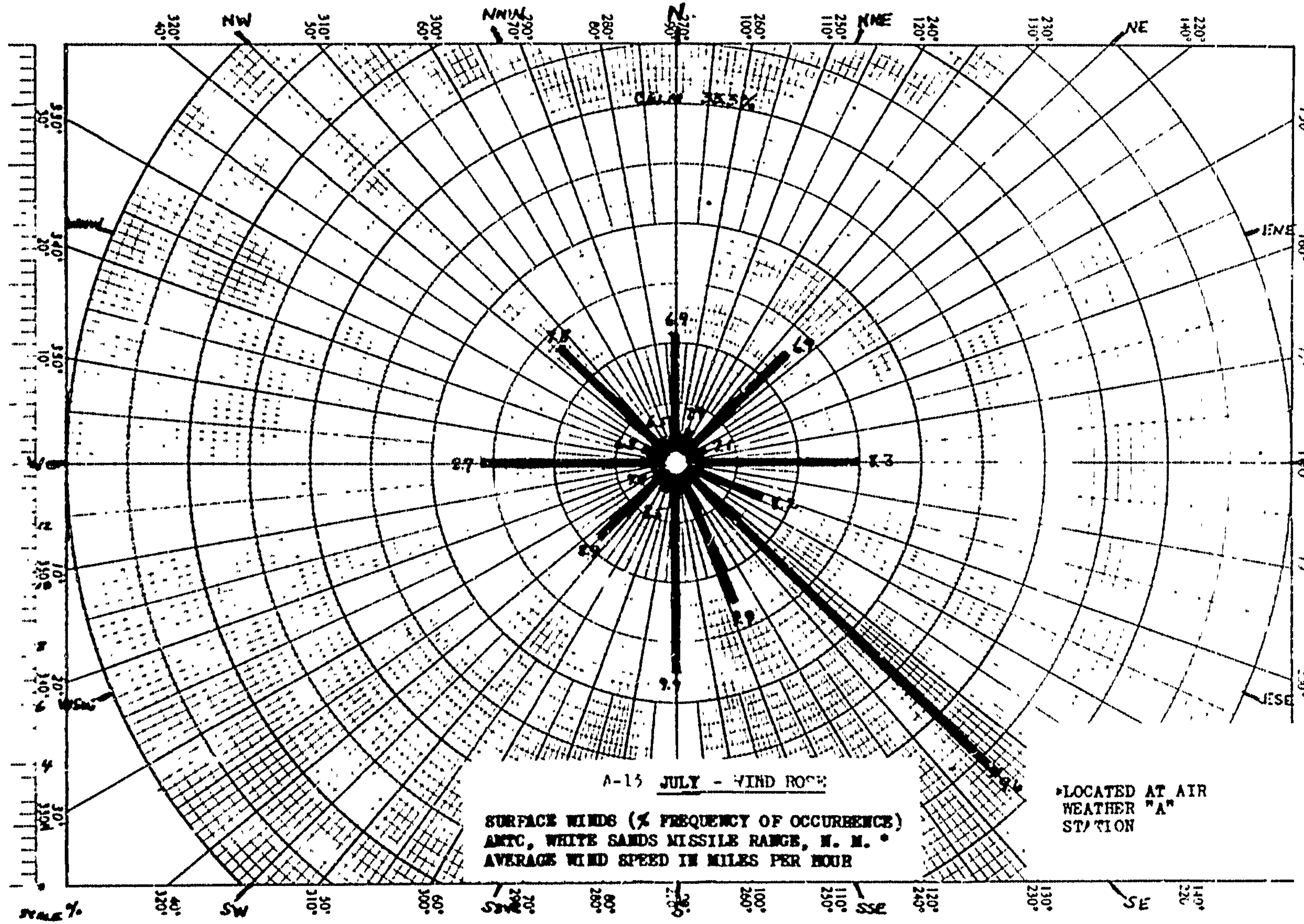
A-11 MAY - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.
AVERAGE WIND SPEED IN MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



A-12 **JUNE** - WIND ROSE

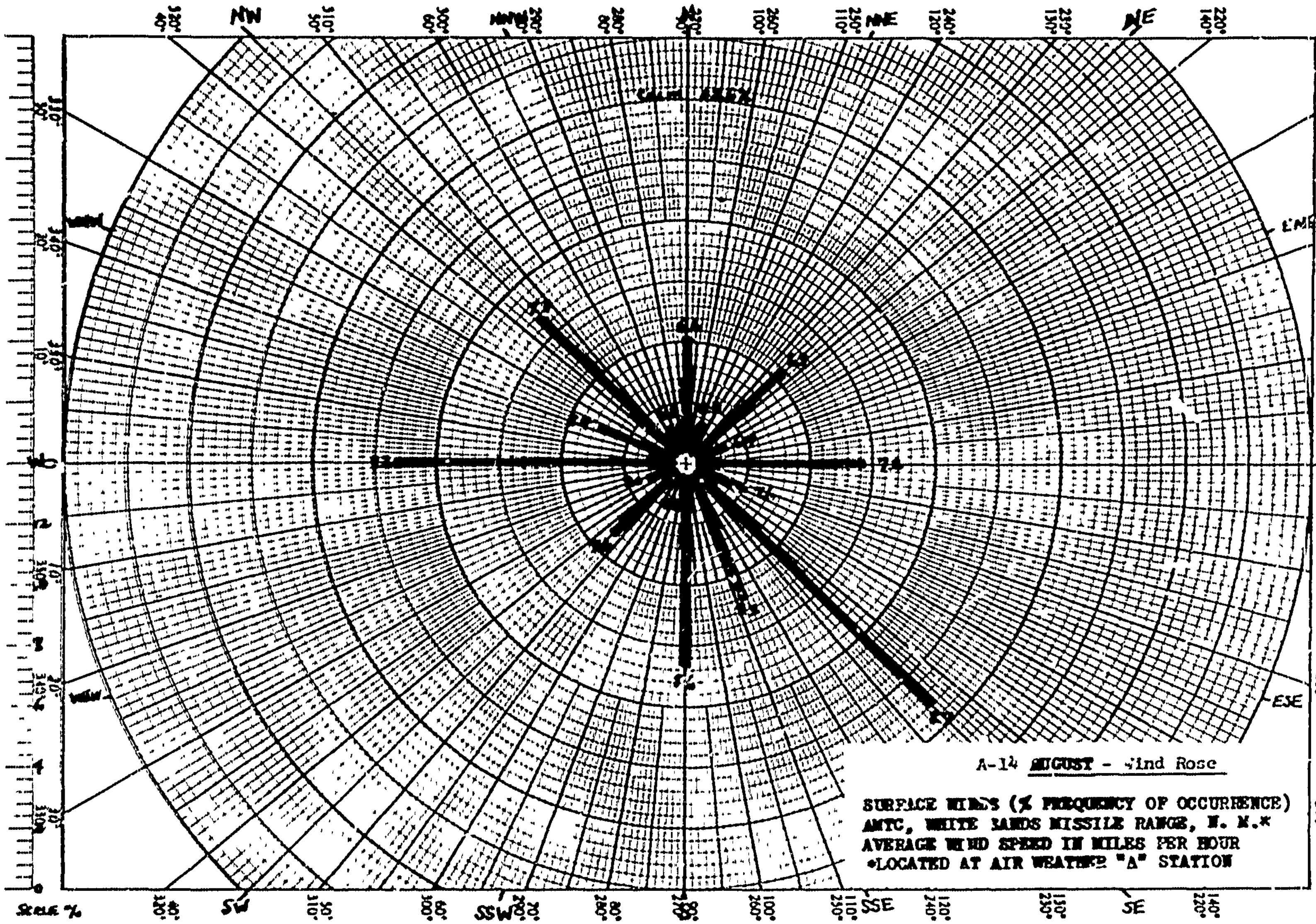
SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
***LOCATED AT AIR WEATHER "A" STATION**



A-15 JULY - WIND ROSE

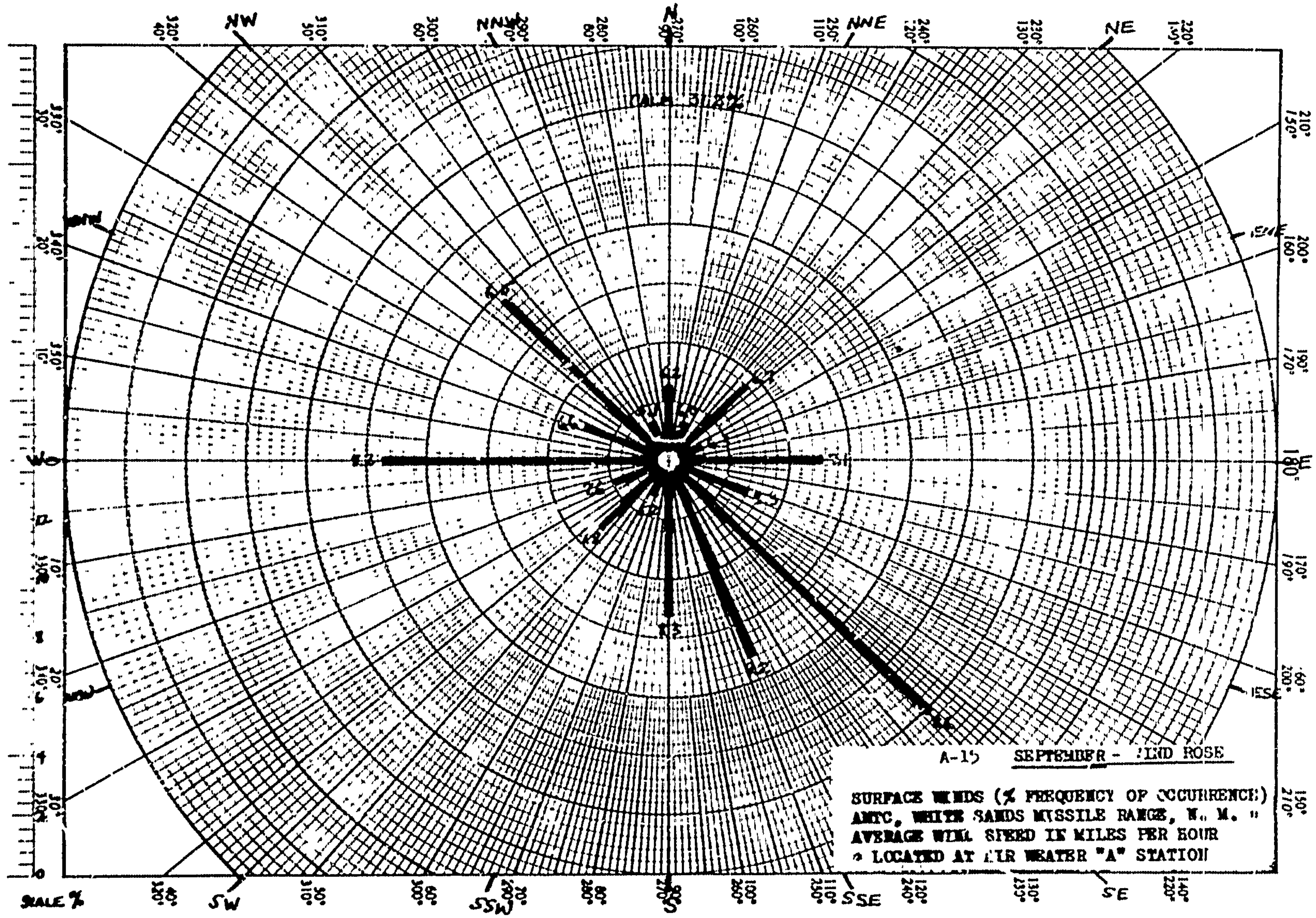
SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M. *
AVERAGE WIND SPEED IN MILES PER HOUR

*LOCATED AT AIR WEATHER "A" STATION



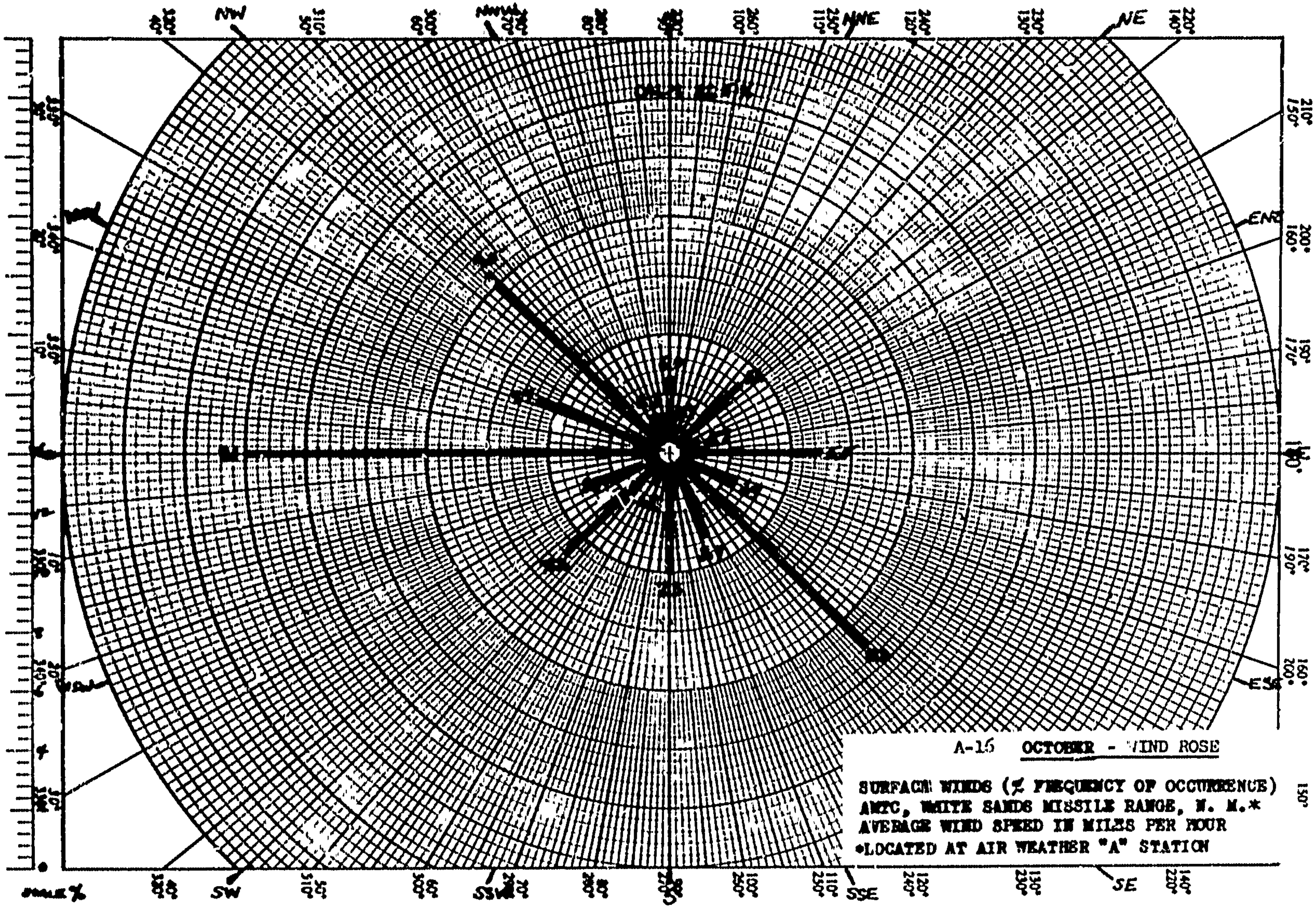
A-14 AUGUST - Wind Rose

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



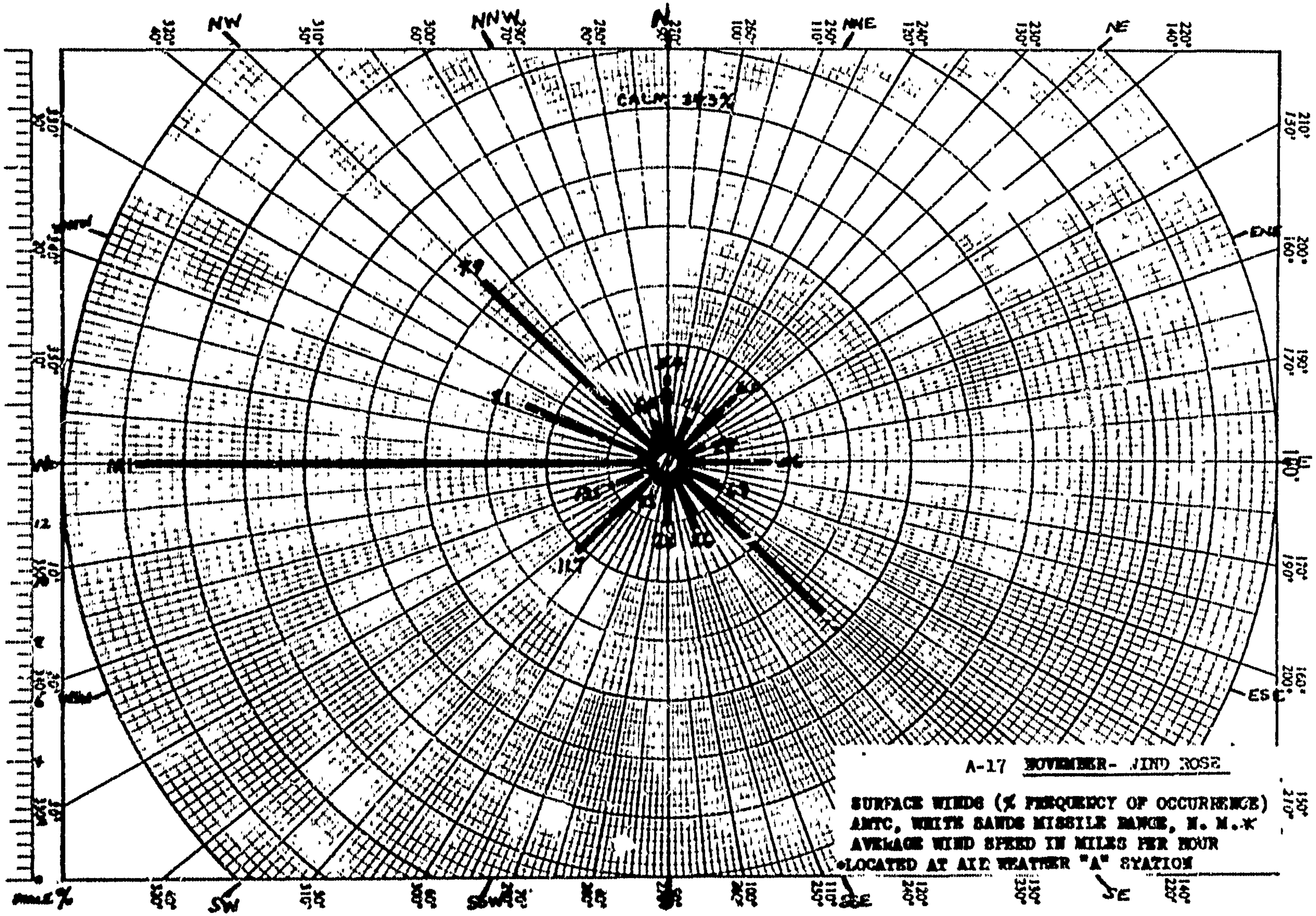
A-15 SEPTEMBER - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M. "
AVERAGE WIND SPEED IN MILES PER HOUR
" LOCATED AT AIR WEATHER "A" STATION



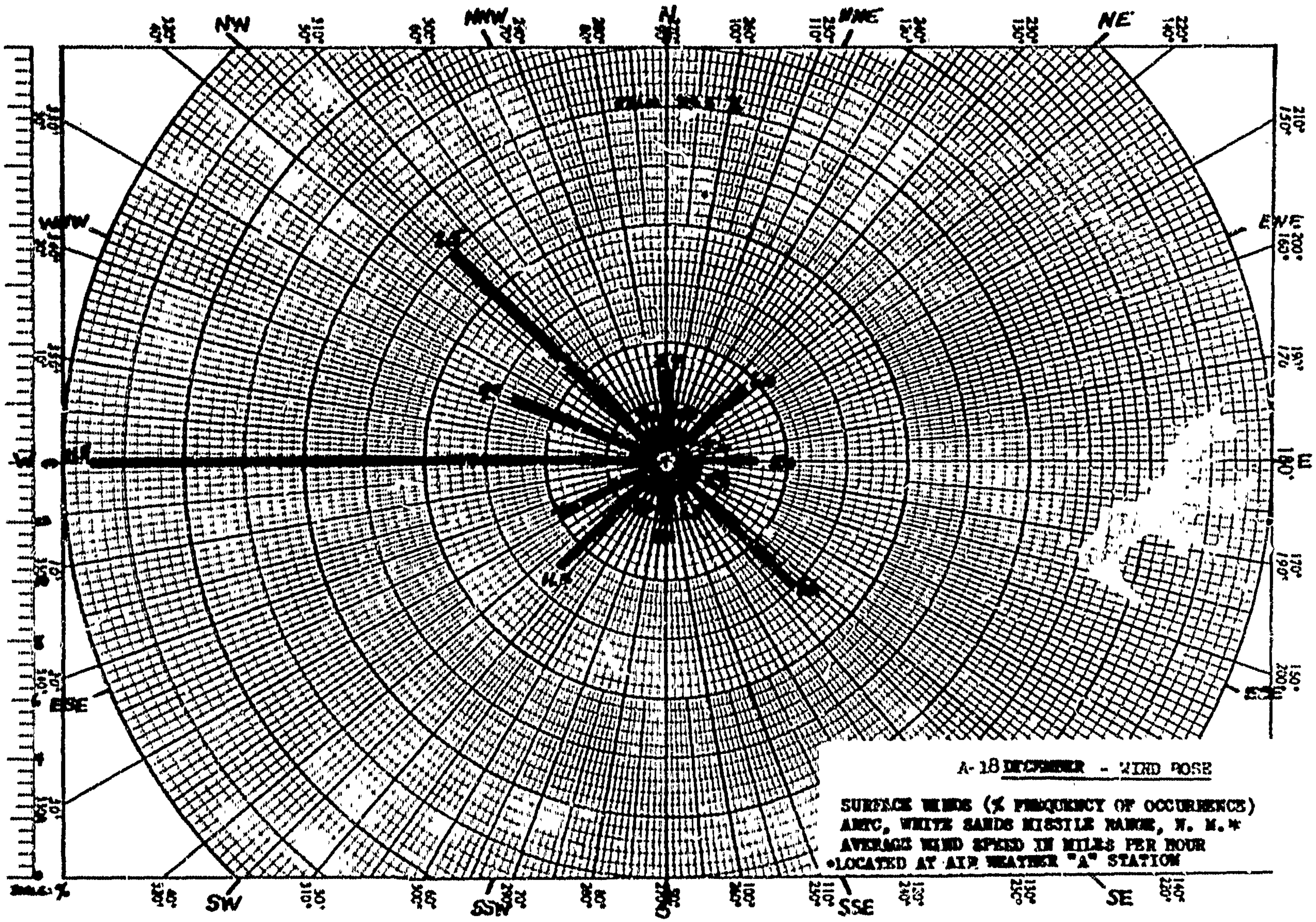
A-15 OCTOBER - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



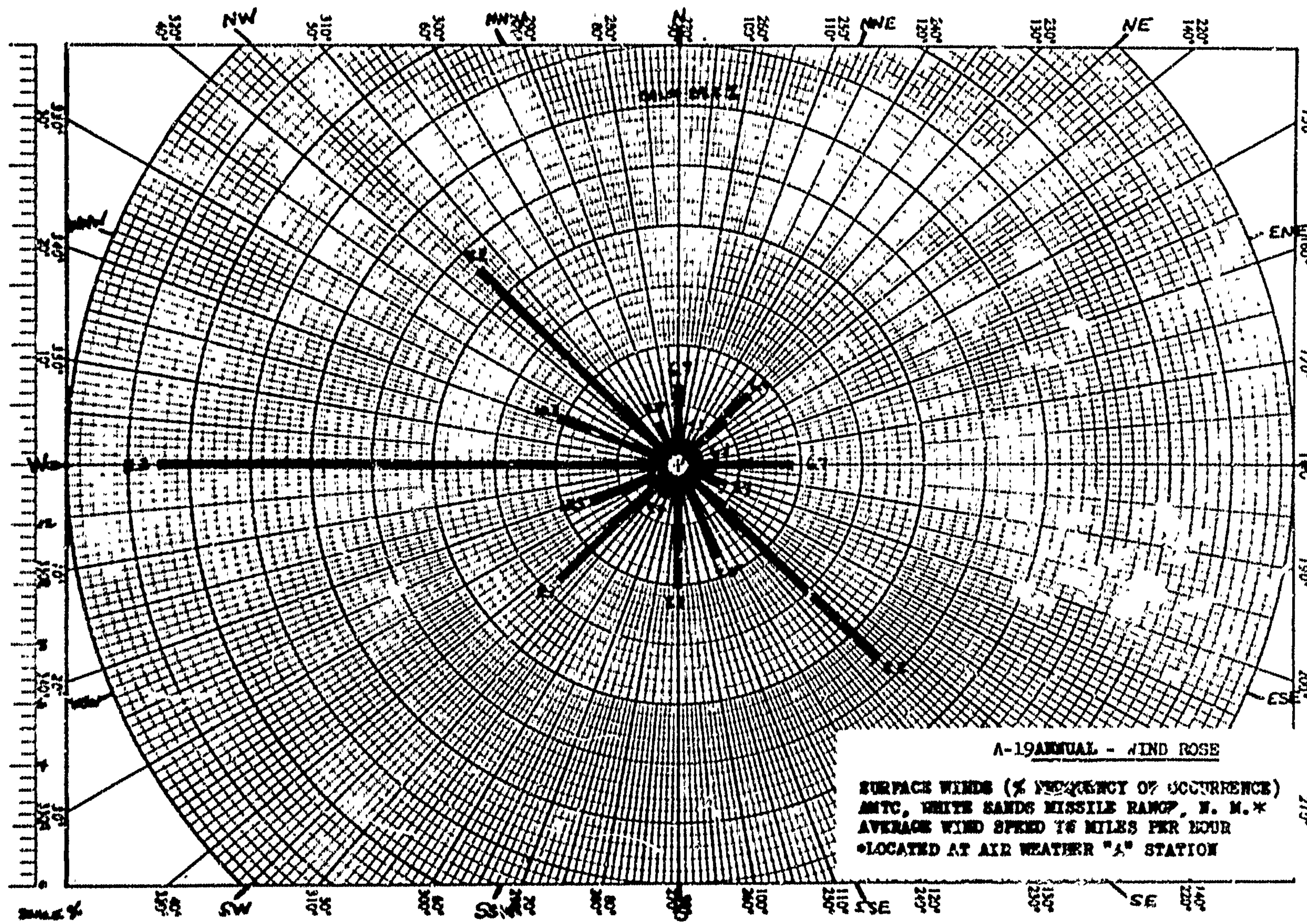
A-17 NOVEMBER- WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



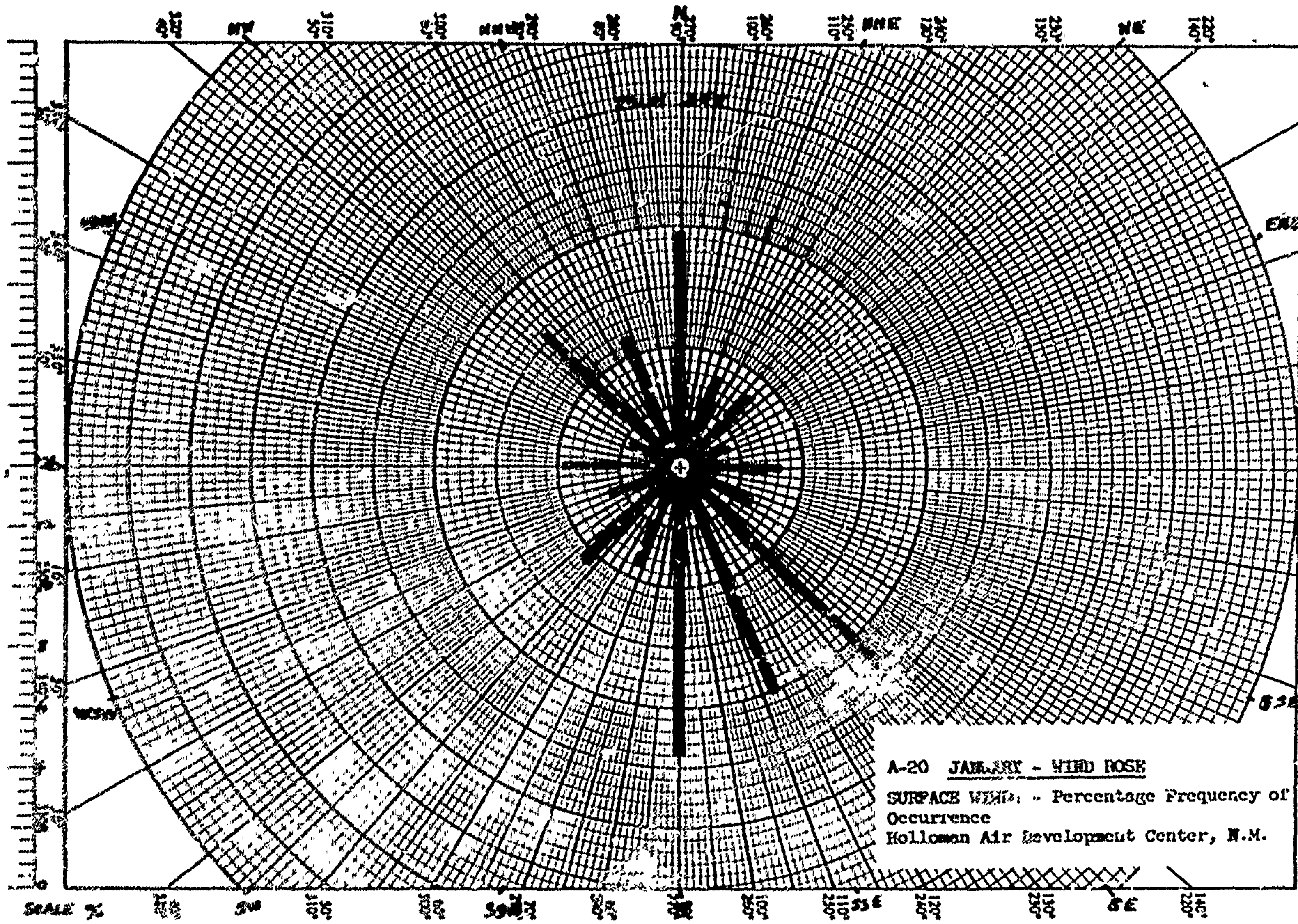
A-18 DECEMBER - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED IN MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



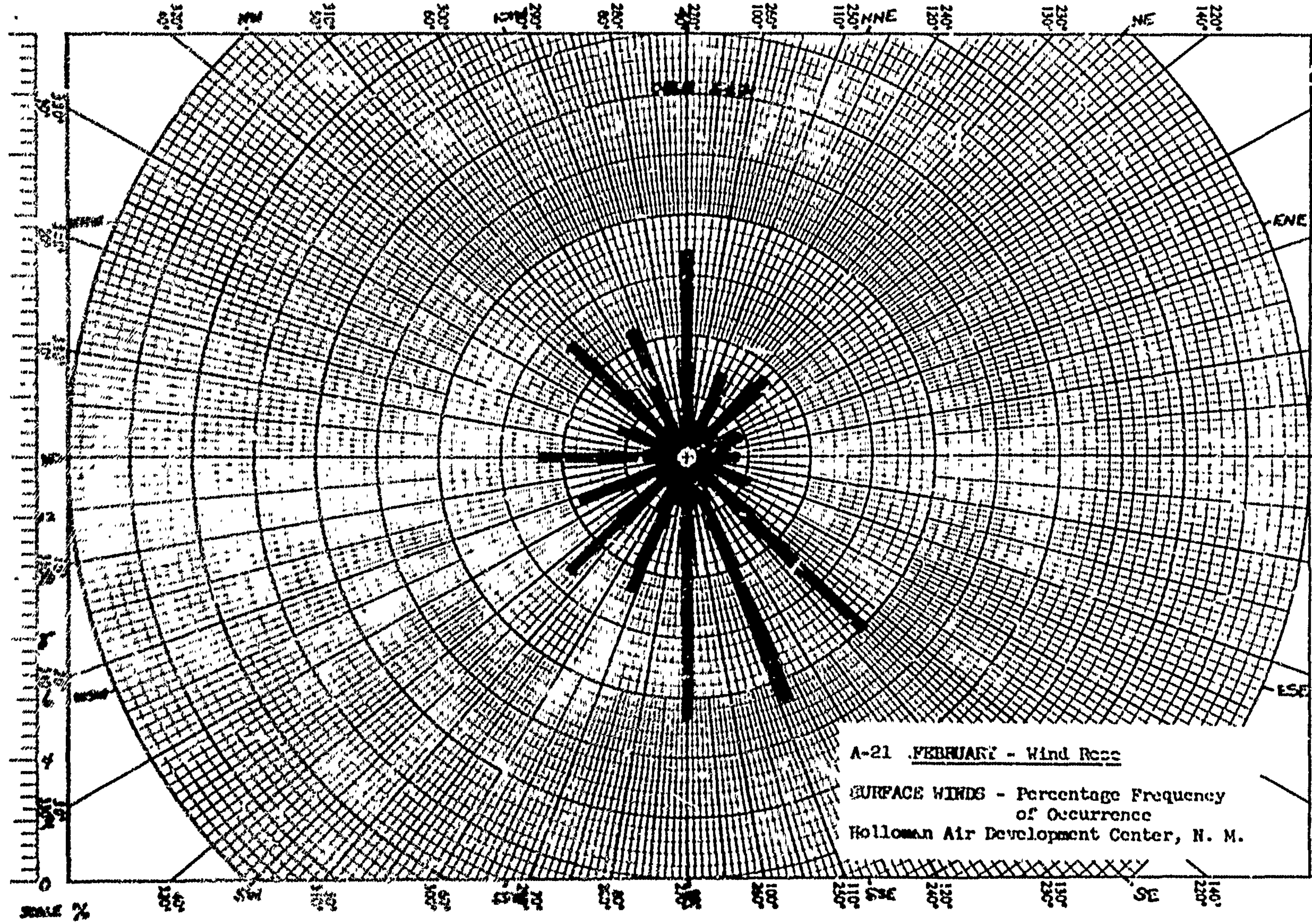
A-19 ANNUAL - WIND ROSE

SURFACE WINDS (% FREQUENCY OF OCCURRENCE)
AMTC, WHITE SANDS MISSILE RANGE, N. M.*
AVERAGE WIND SPEED 16 MILES PER HOUR
*LOCATED AT AIR WEATHER "A" STATION



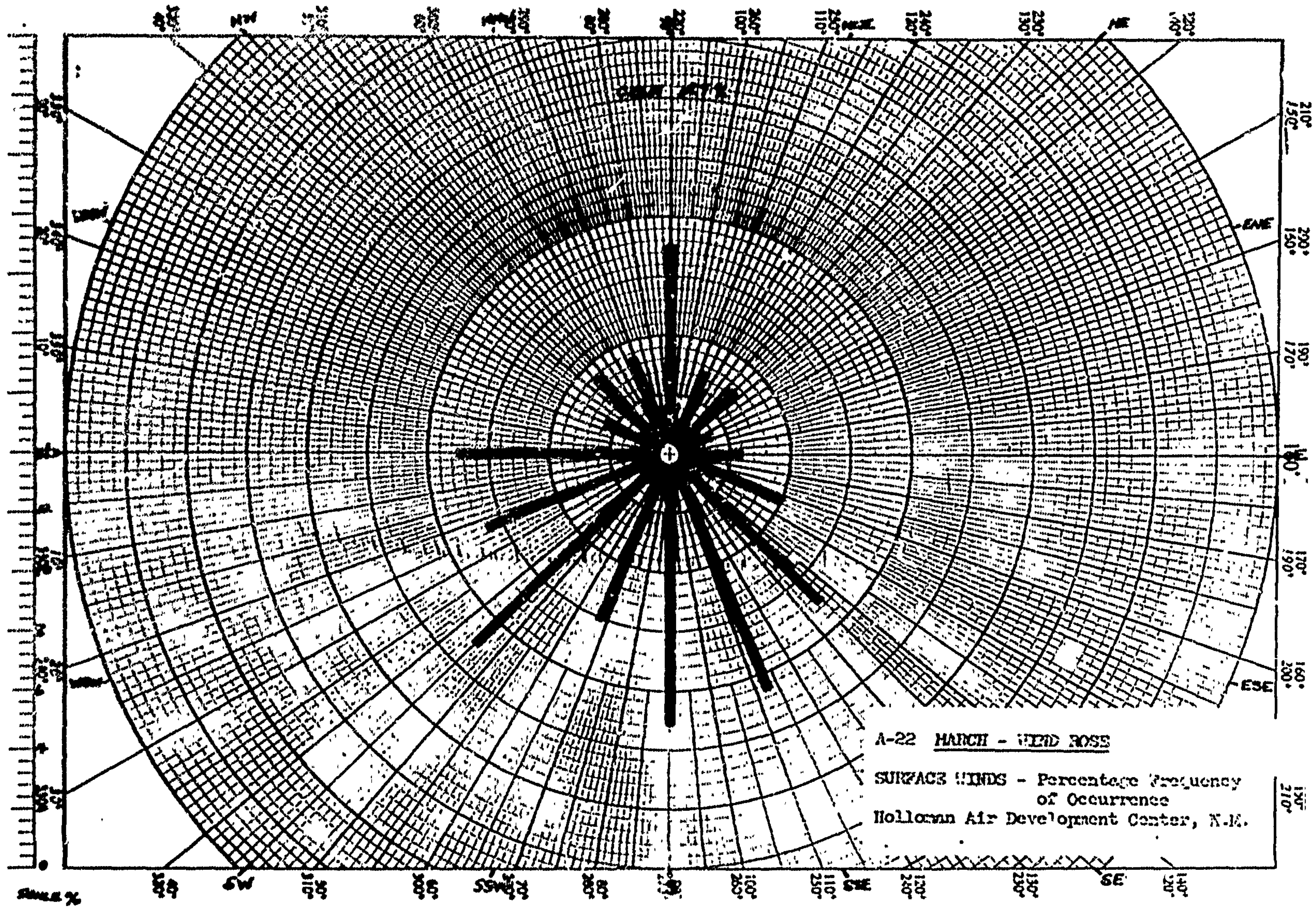
A-20 JANUARY - WIND ROSE

SURFACE WIND - Percentage Frequency of Occurrence
Holloman Air Development Center, N.M.



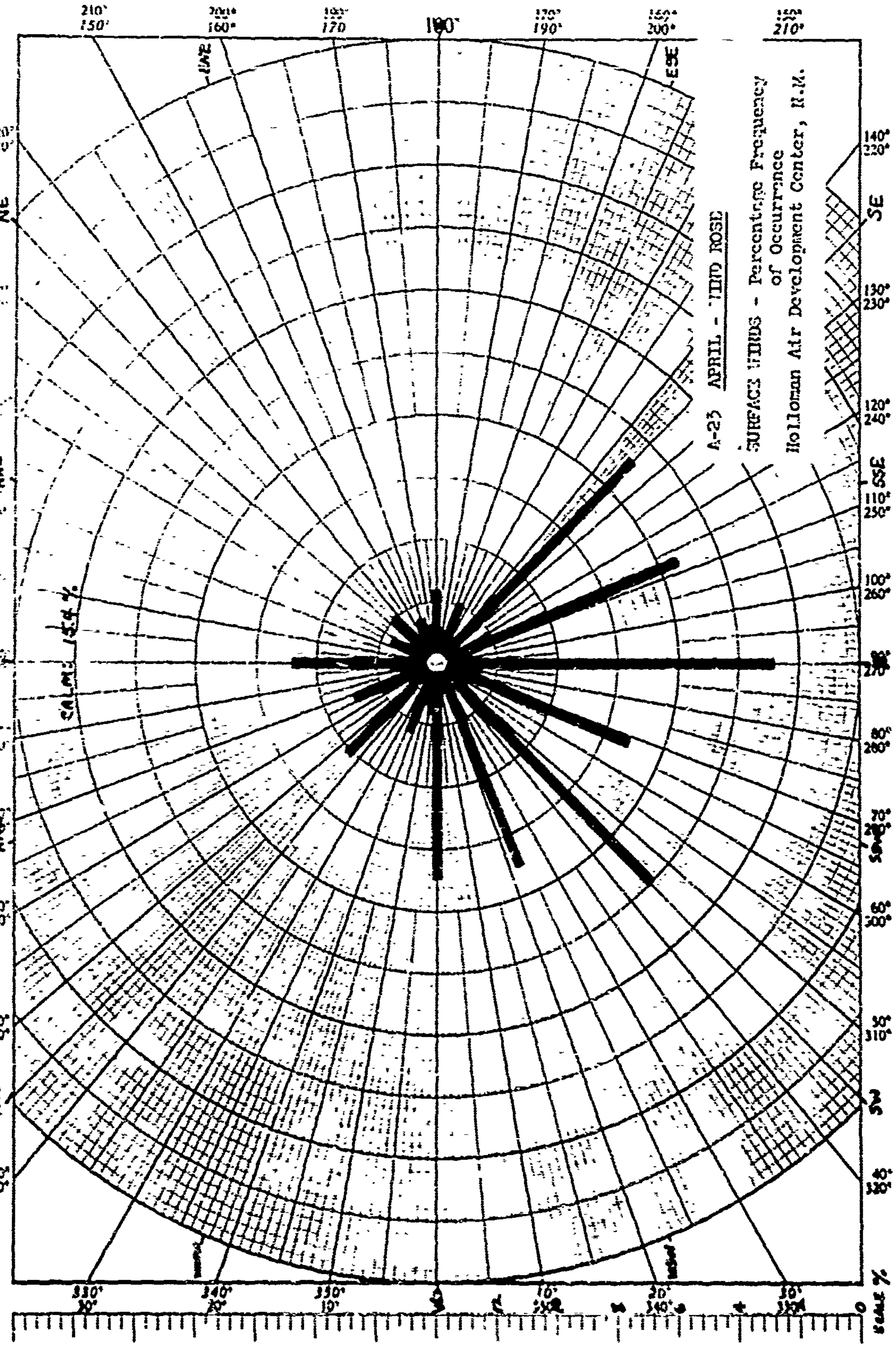
A-21 FEBRUARY - Wind Rose

SURFACE WINDS - Percentage Frequency of Occurrence
Holloman Air Development Center, N. M.



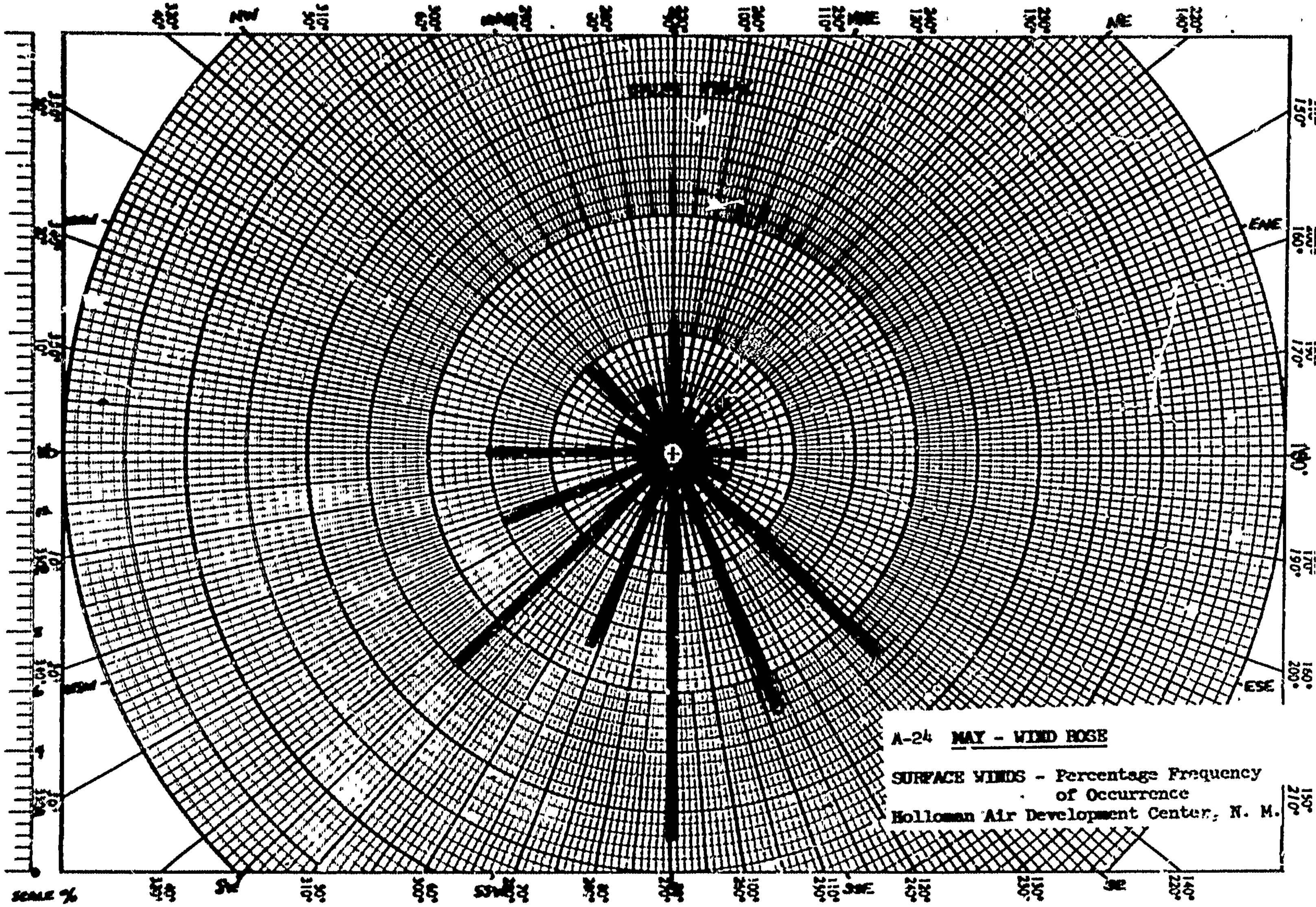
A-22 MARCH - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence
Holloman Air Development Center, N.M.



A-23 APRIL - WIND ROSE

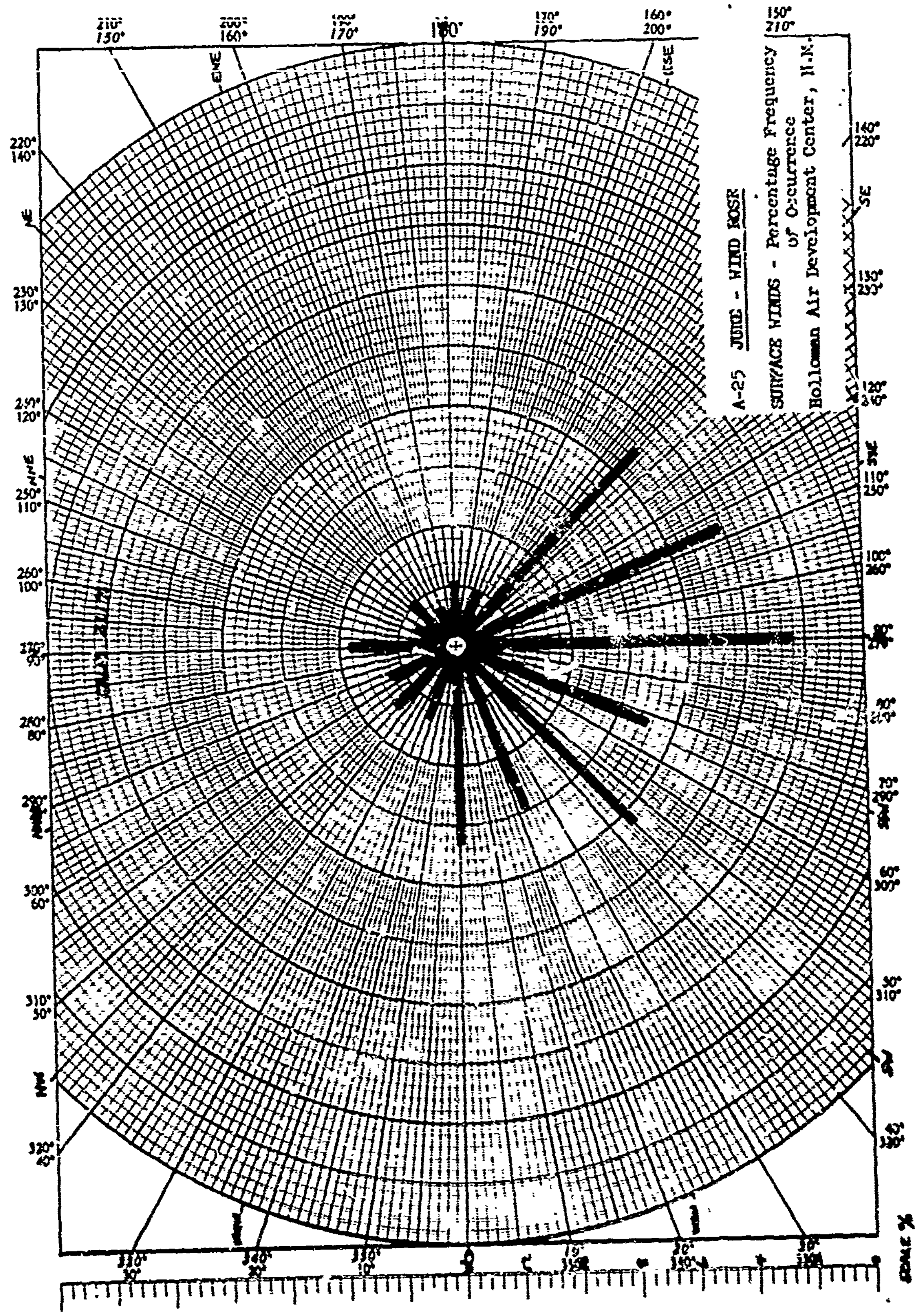
SURFACE WINDS - Percentage Frequency of Occurrence Holloman Air Development Center, N.M.



A-24 MAY - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence

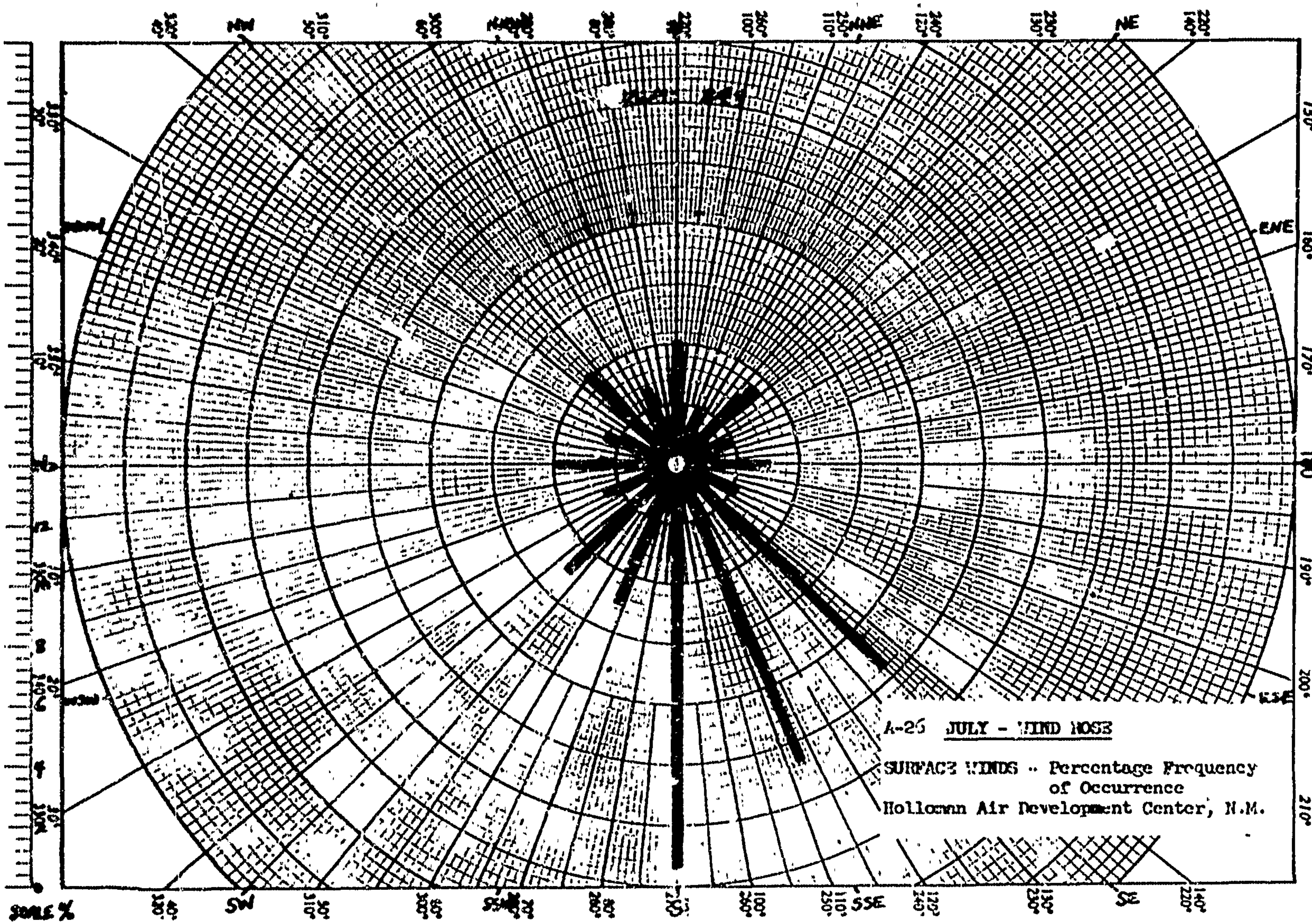
Holloman Air Development Center, N. M.



A-25 JUNE - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence

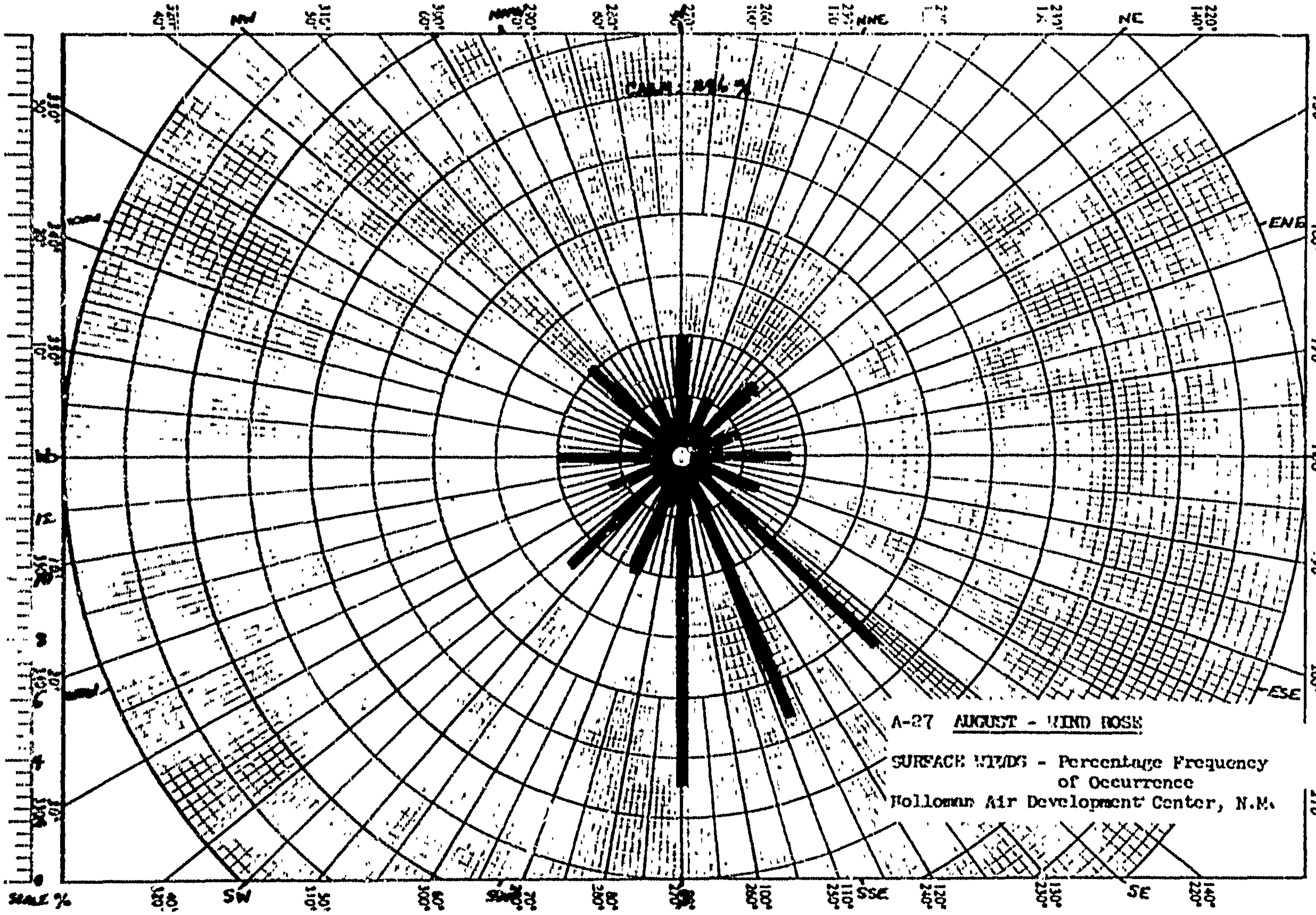
Holloman Air Development Center, N.M.



A-26 JULY - WIND ROSE

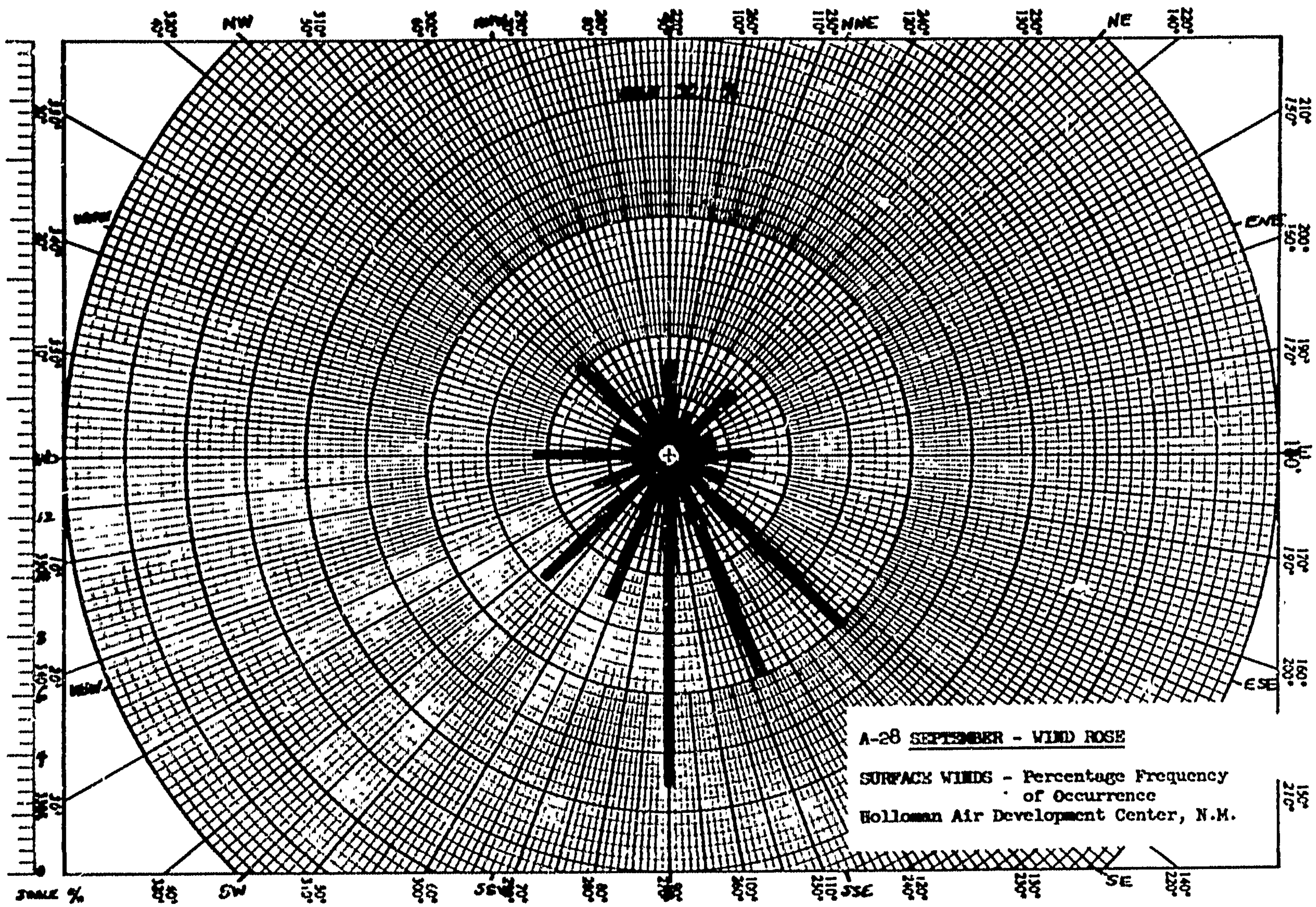
SURFACE WINDS - Percentage Frequency of Occurrence

Holloman Air Development Center, N.M.



A-27 AUGUST - WIND ROSE

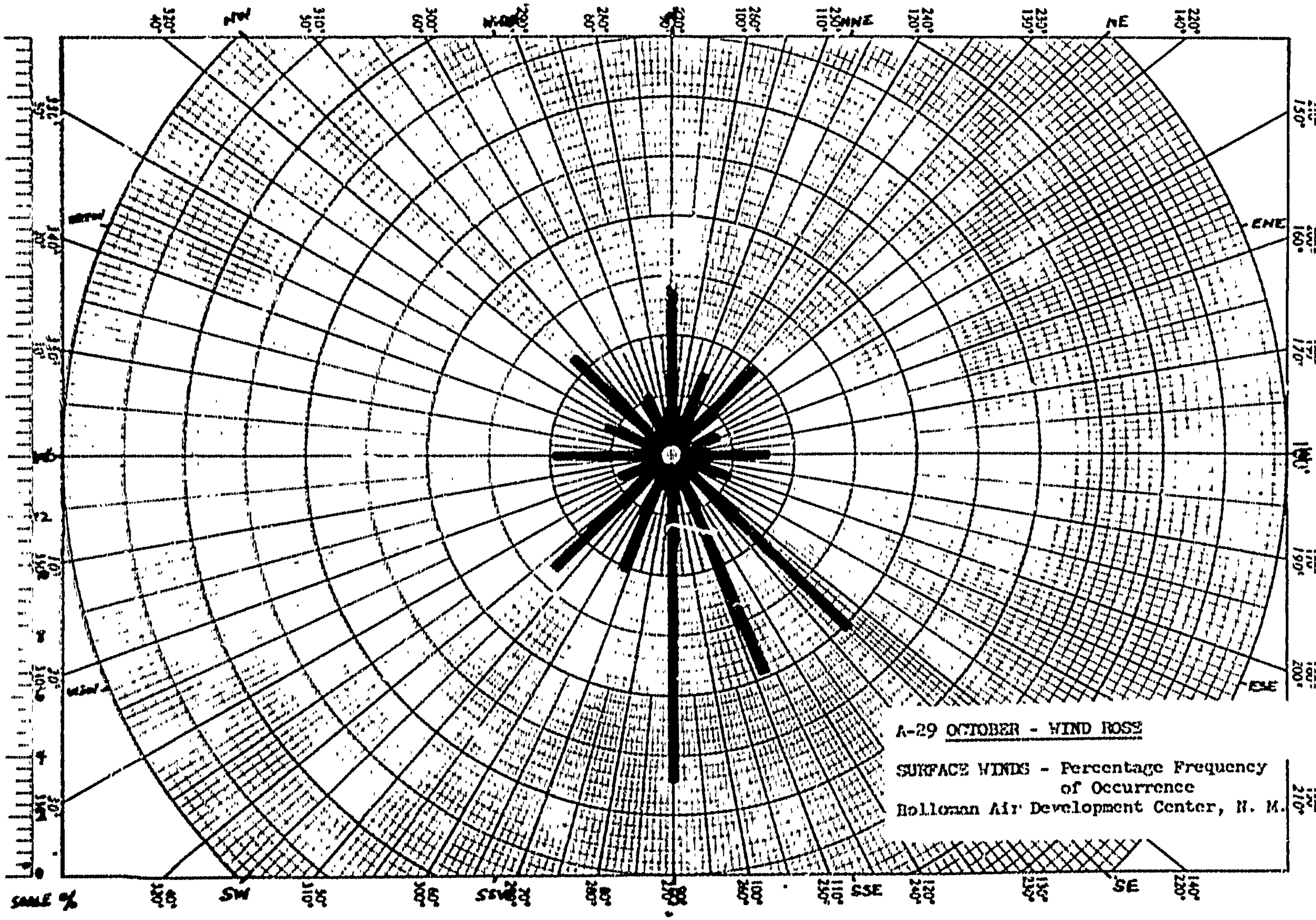
SURFACE WINDS - Percentage Frequency of Occurrence
Holloman Air Development Center, N.M.



A-28 SEPTEMBER - WIND ROSE

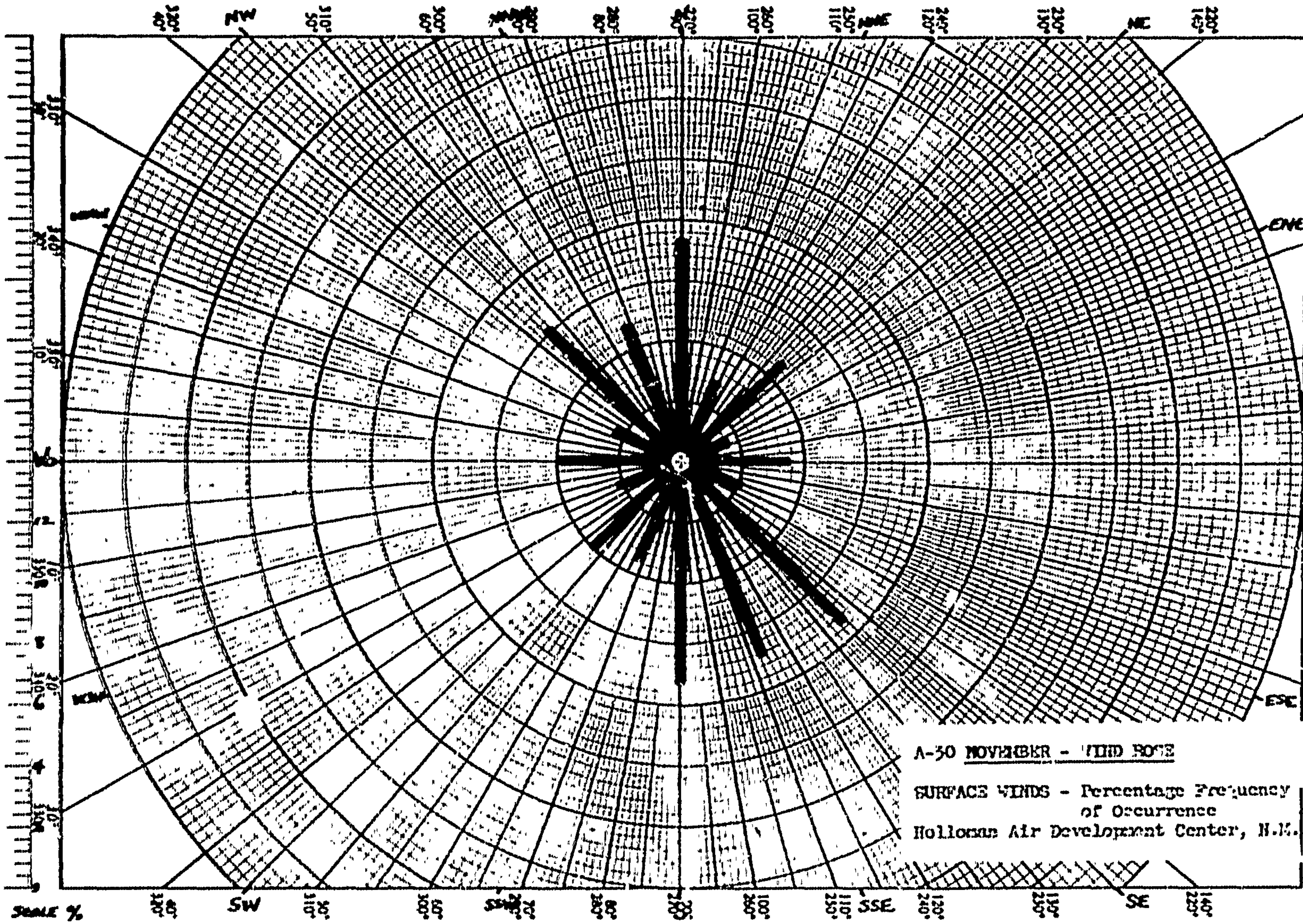
SURFACE WINDS - Percentage Frequency of Occurrence

Holloman Air Development Center, N.M.



A-29 OCTOBER - WIND ROSE

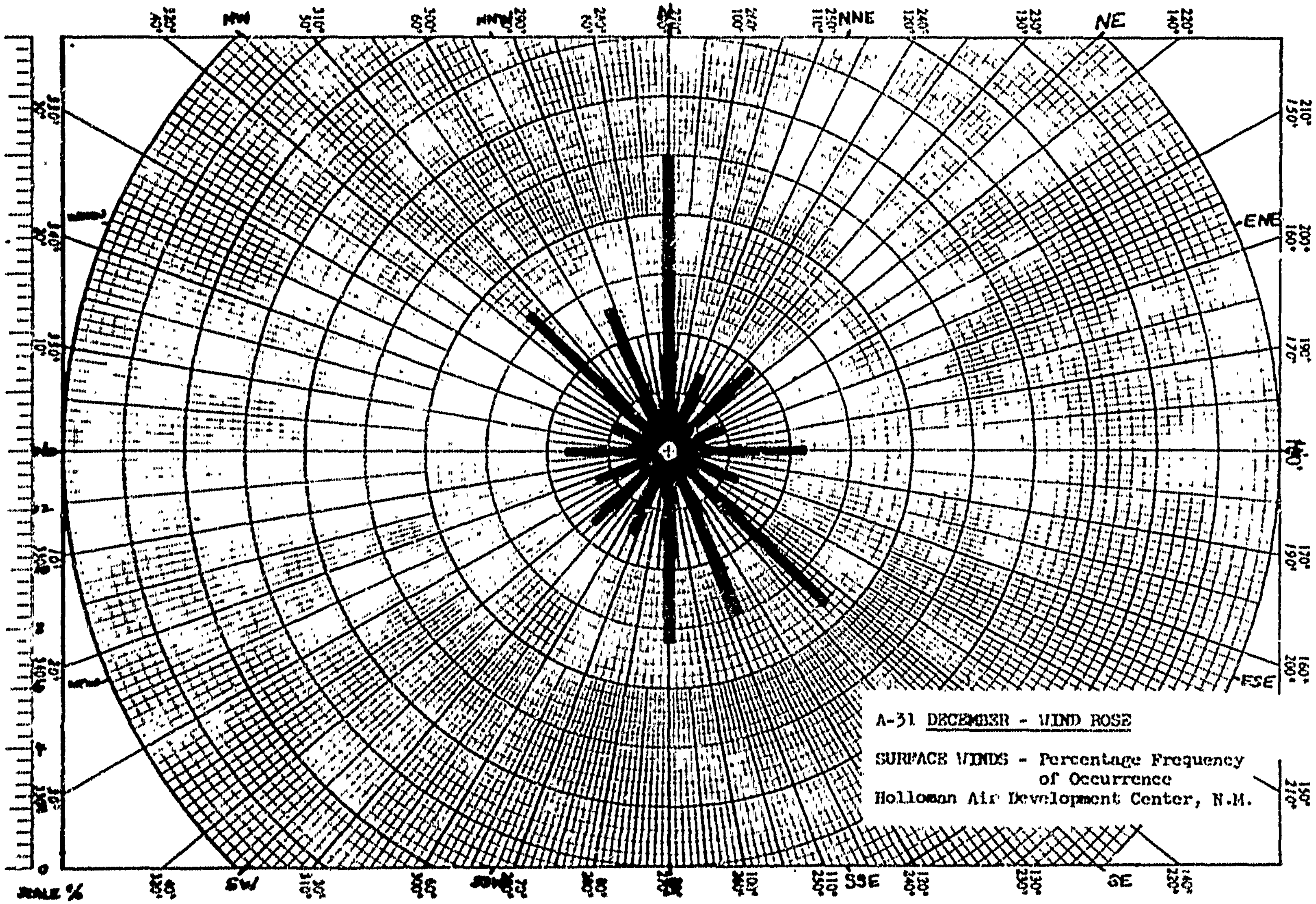
SURFACE WINDS - Percentage Frequency of Occurrence
Holloman Air Development Center, N. M.



A-30 NOVEMBER - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence

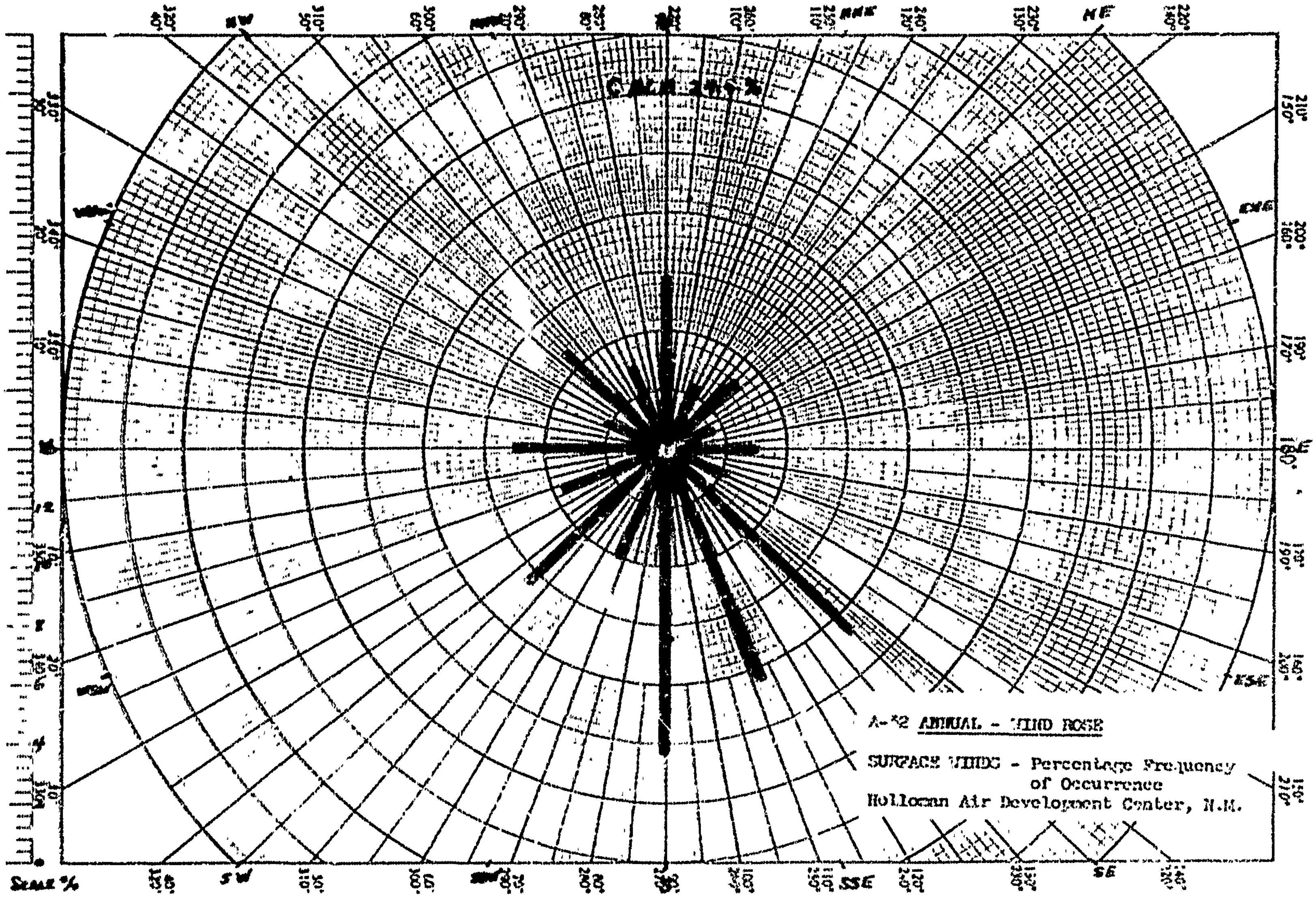
Holloman Air Development Center, N.M.



A-31 DECEMBER - WIND ROSE

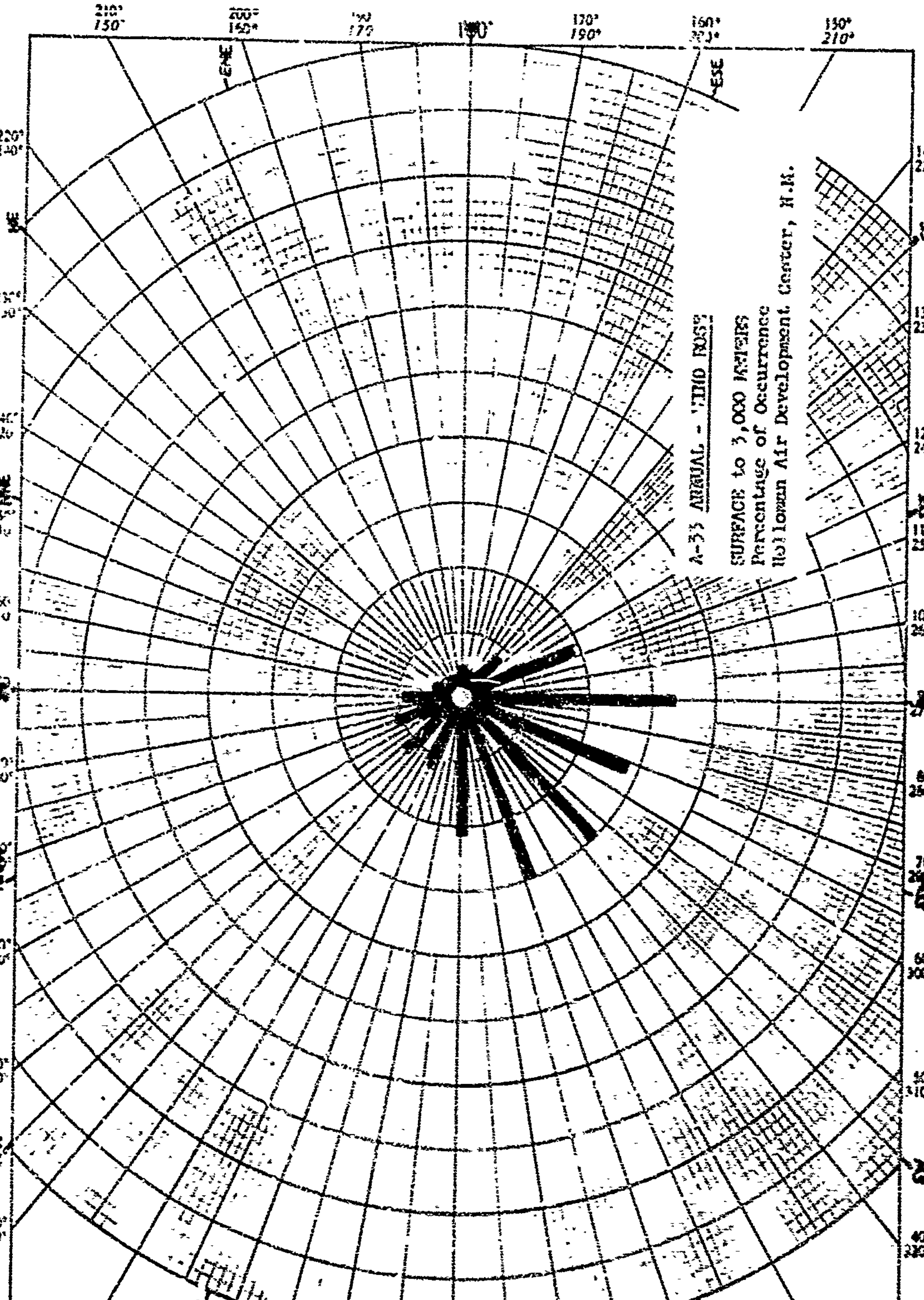
SURFACE WINDS - Percentage Frequency of Occurrence

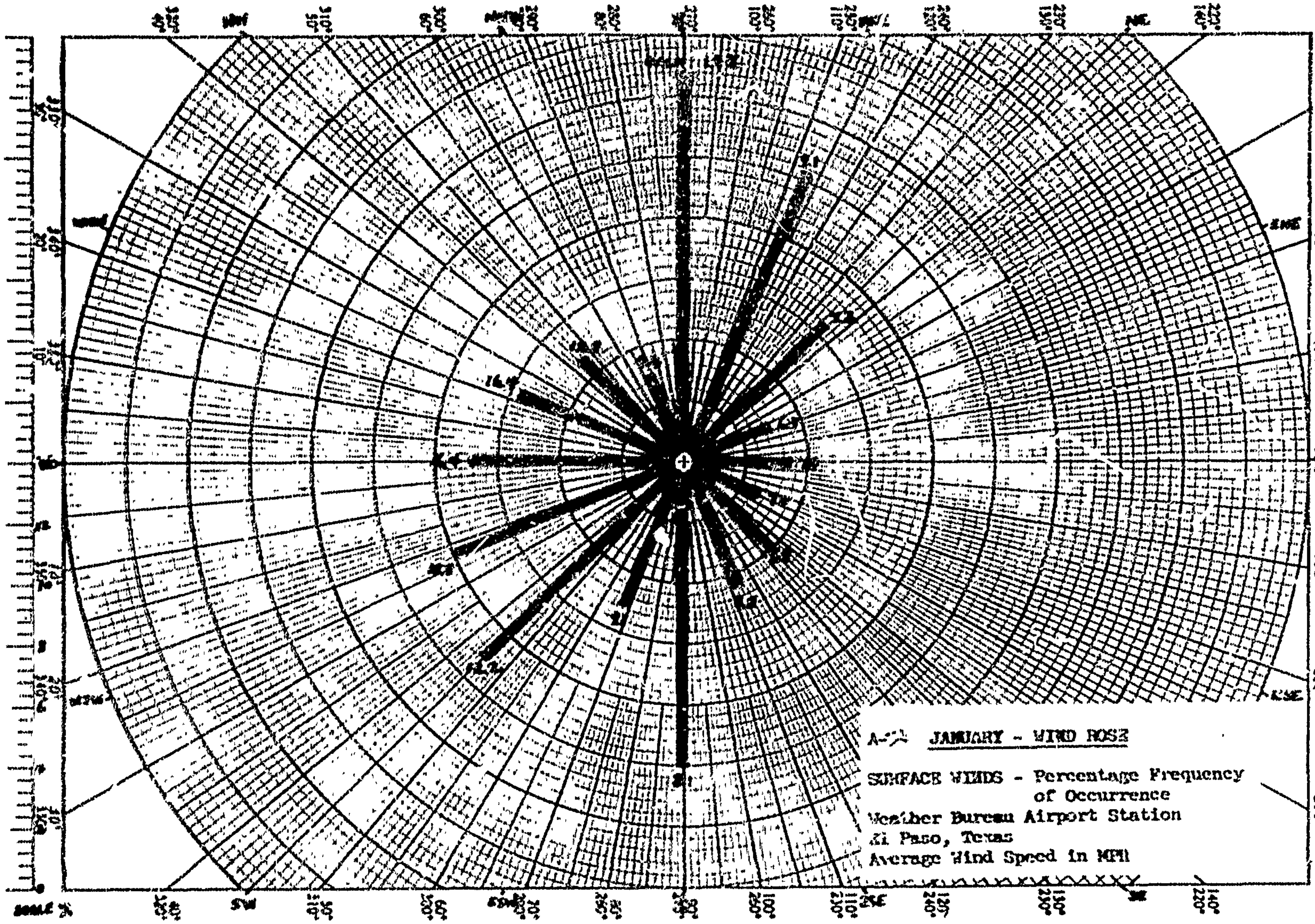
Holloman Air Development Center, N.M.



A-32 <u>ANNUAL - WIND ROSE</u>

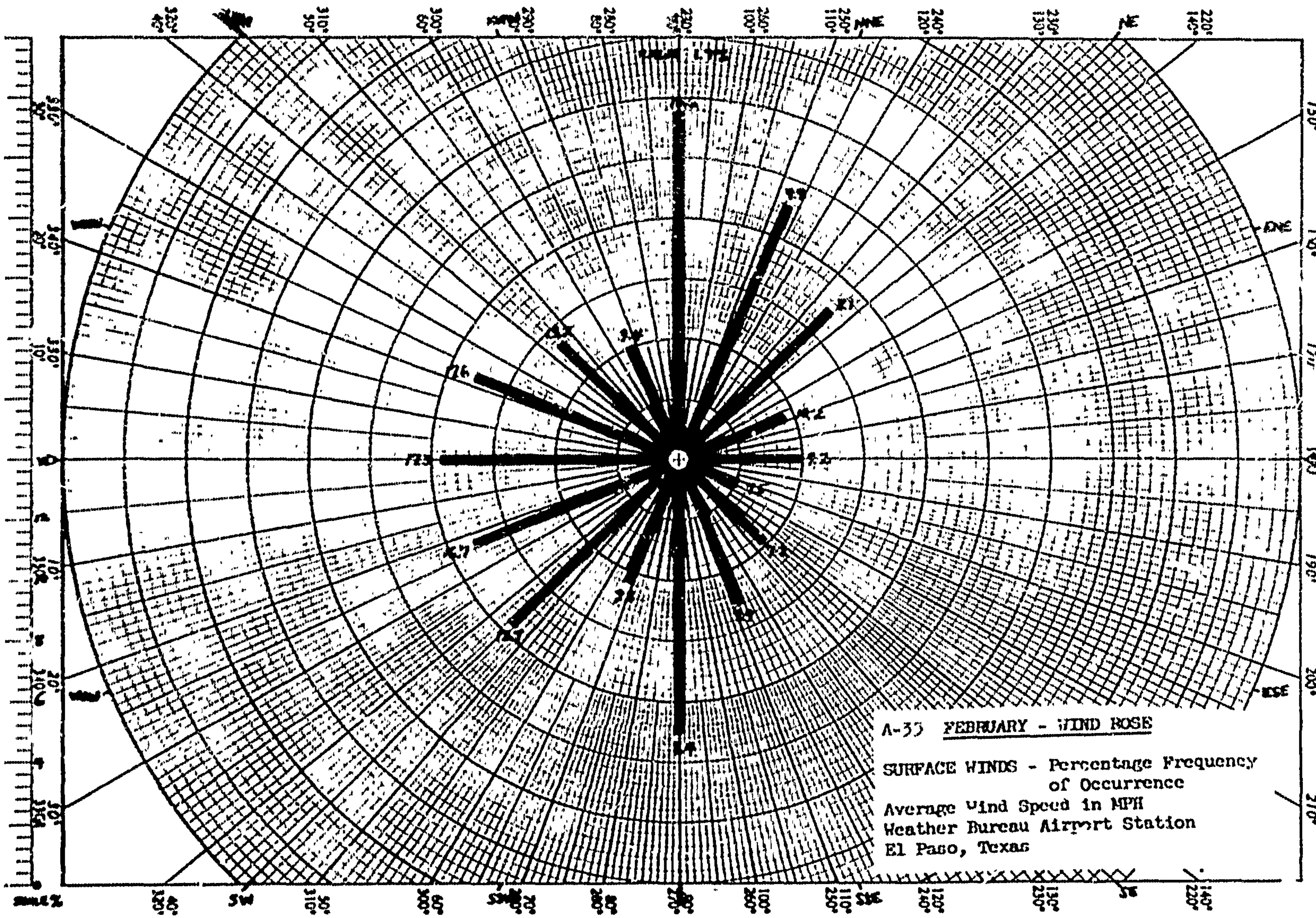
SURFACE WINDS - Percentage Frequency
of Occurrence
Holloman Air Development Center, N.M.


A-33 ANNUAL - WIND ROSE
SURFACE to 3,000 METERS
Percentage of Occurrence
Holloman Air Development Center, N.M.



A-[illegible] JANUARY - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence
Weather Bureau Airport Station
El Paso, Texas
Average Wind Speed in MPH



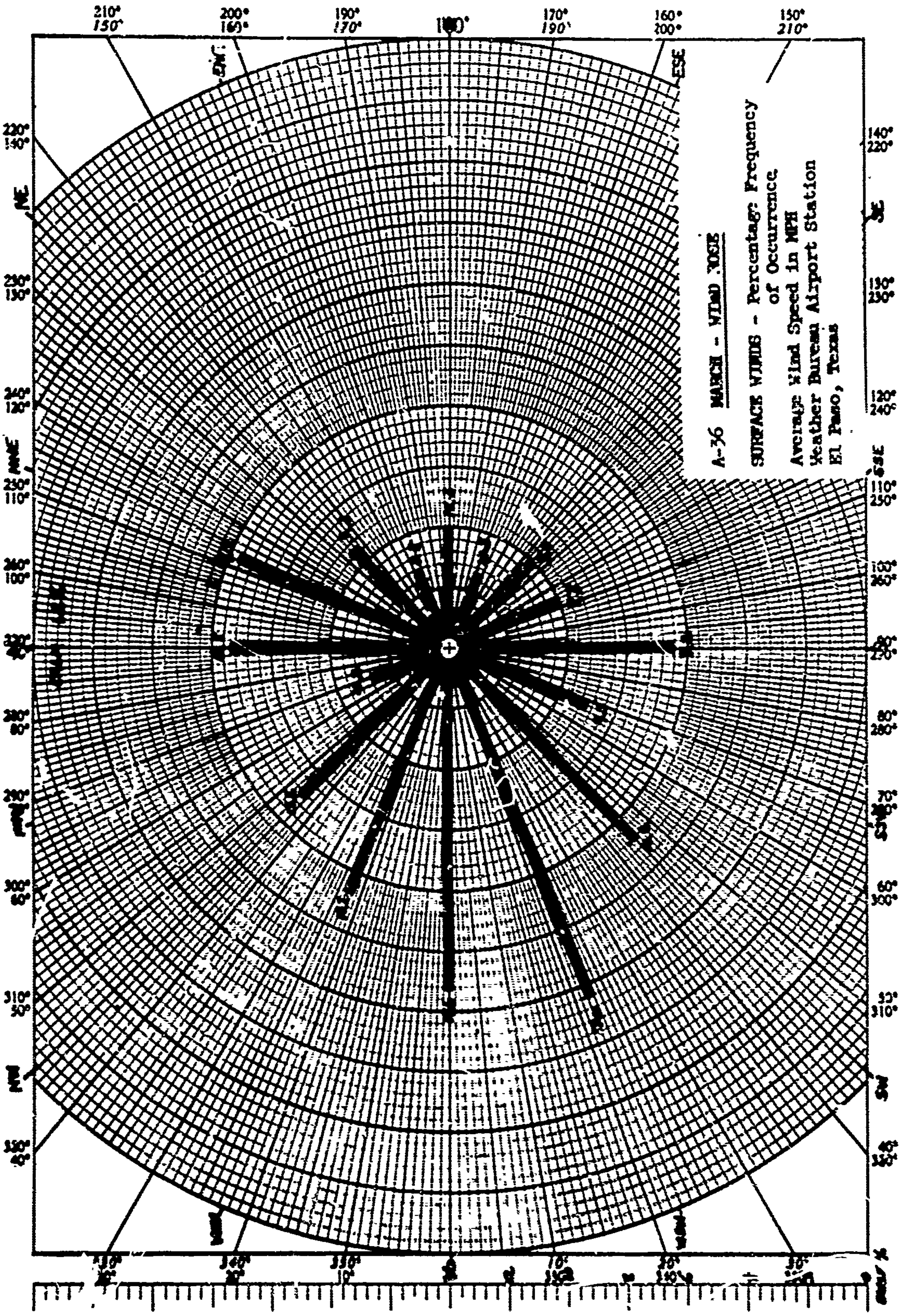
A-33 FEBRUARY - WIND ROSE

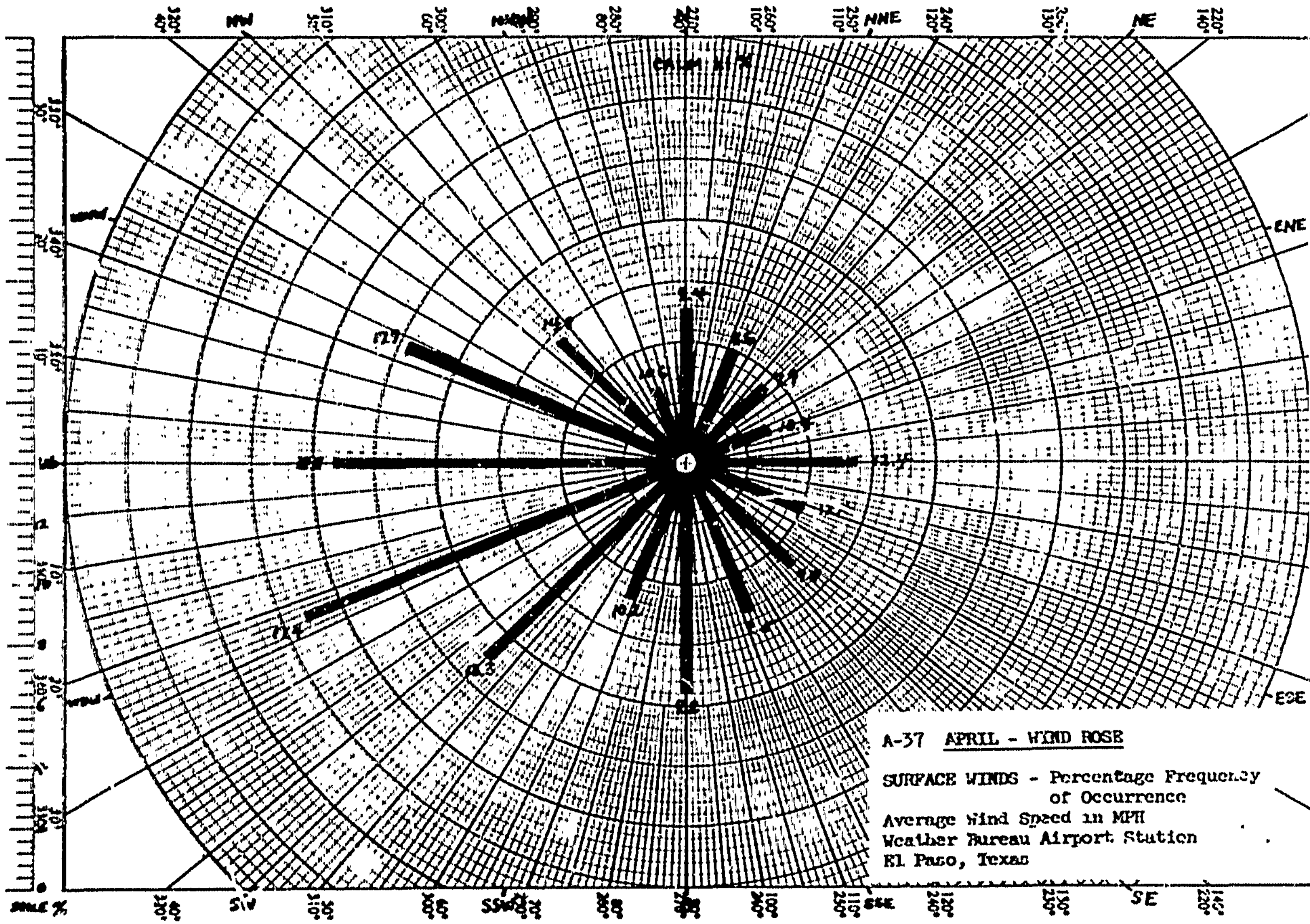
SURFACE WINDS - Percentage Frequency of Occurrence

Average Wind Speed in MPH

Weather Bureau Airport Station

El Paso, Texas

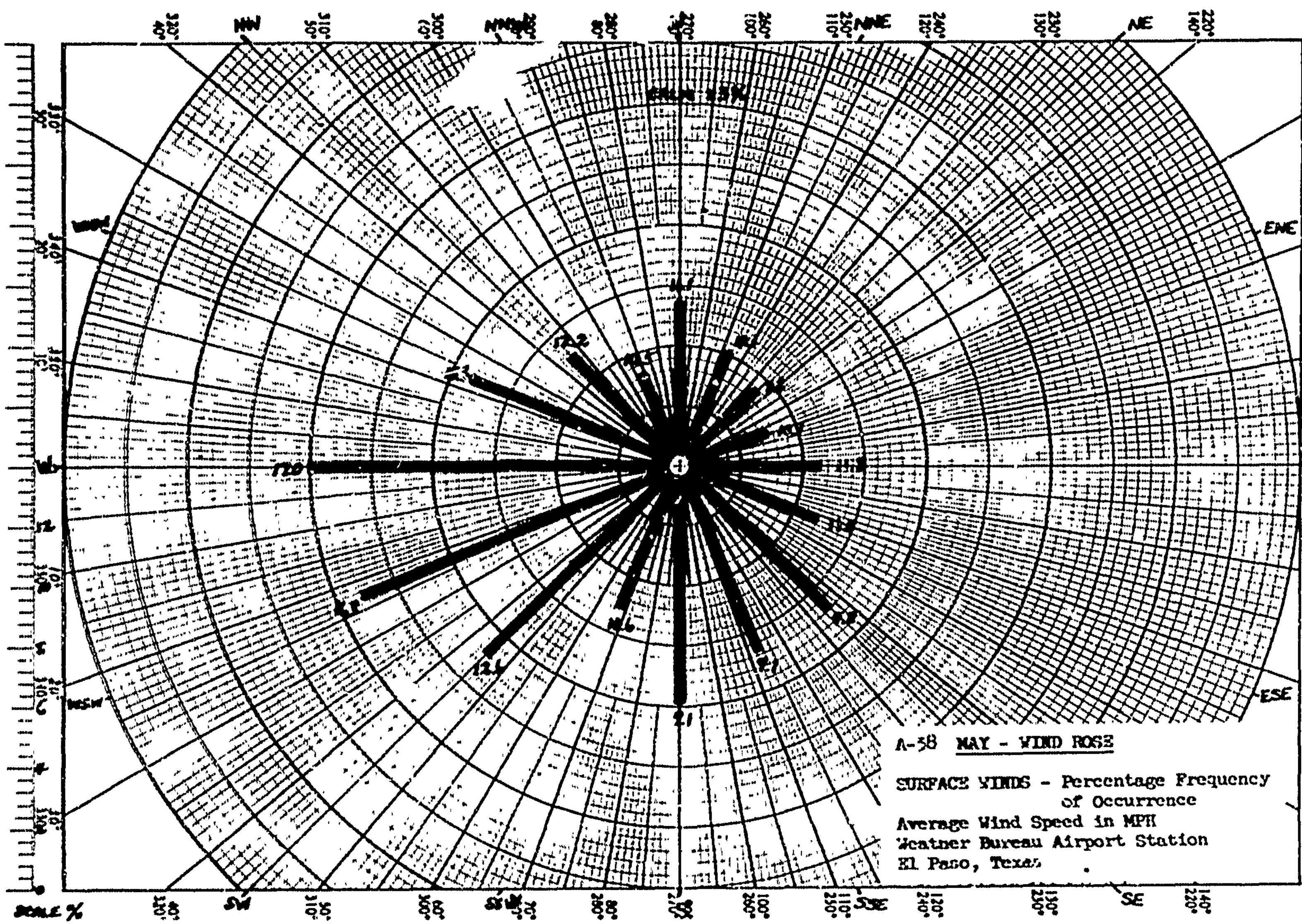

A-36 MARCH - WIND ROSE
SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas



A-37 APRIL - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence

Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas



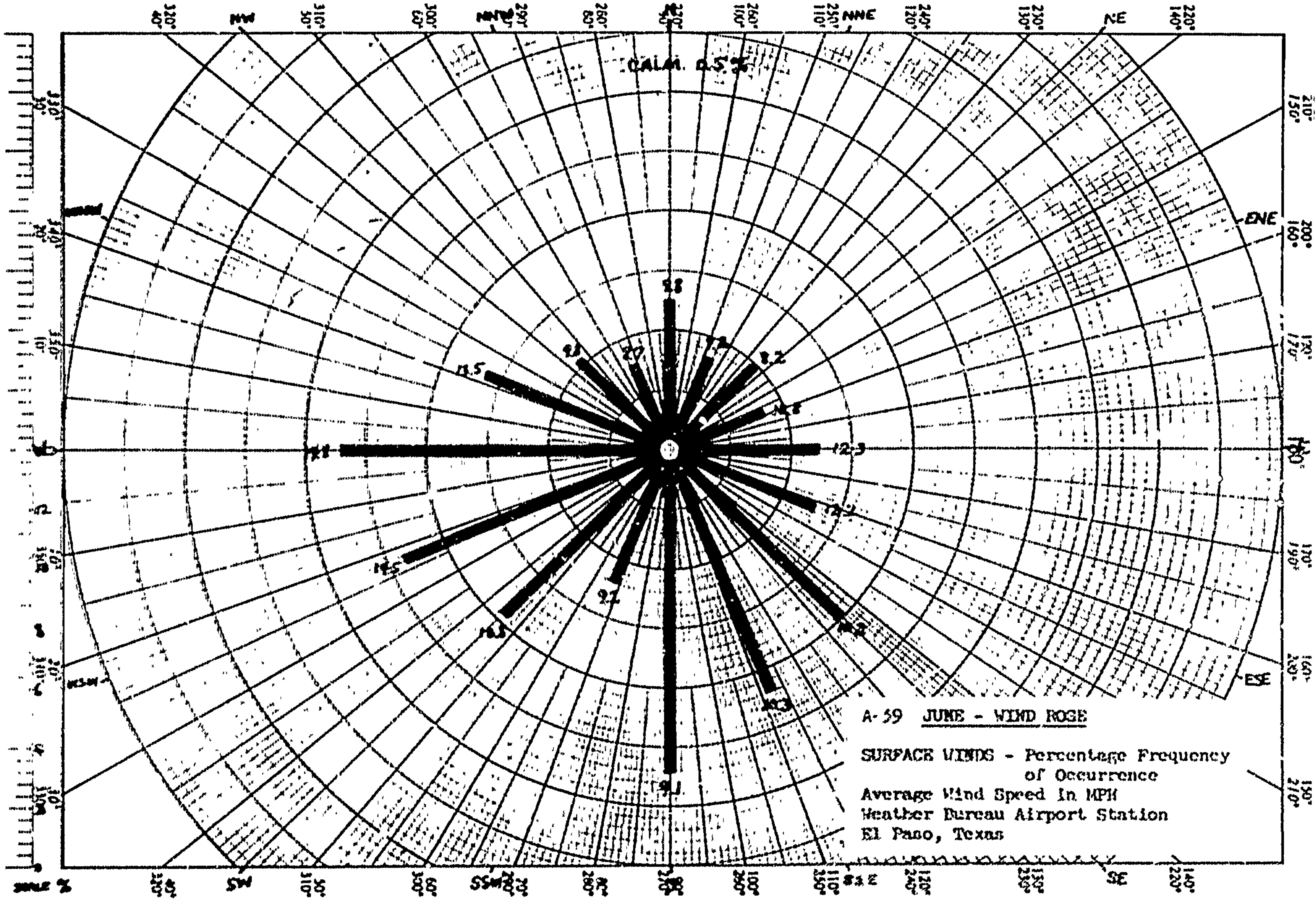
A-58 MAY - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence

Average Wind Speed in MPH

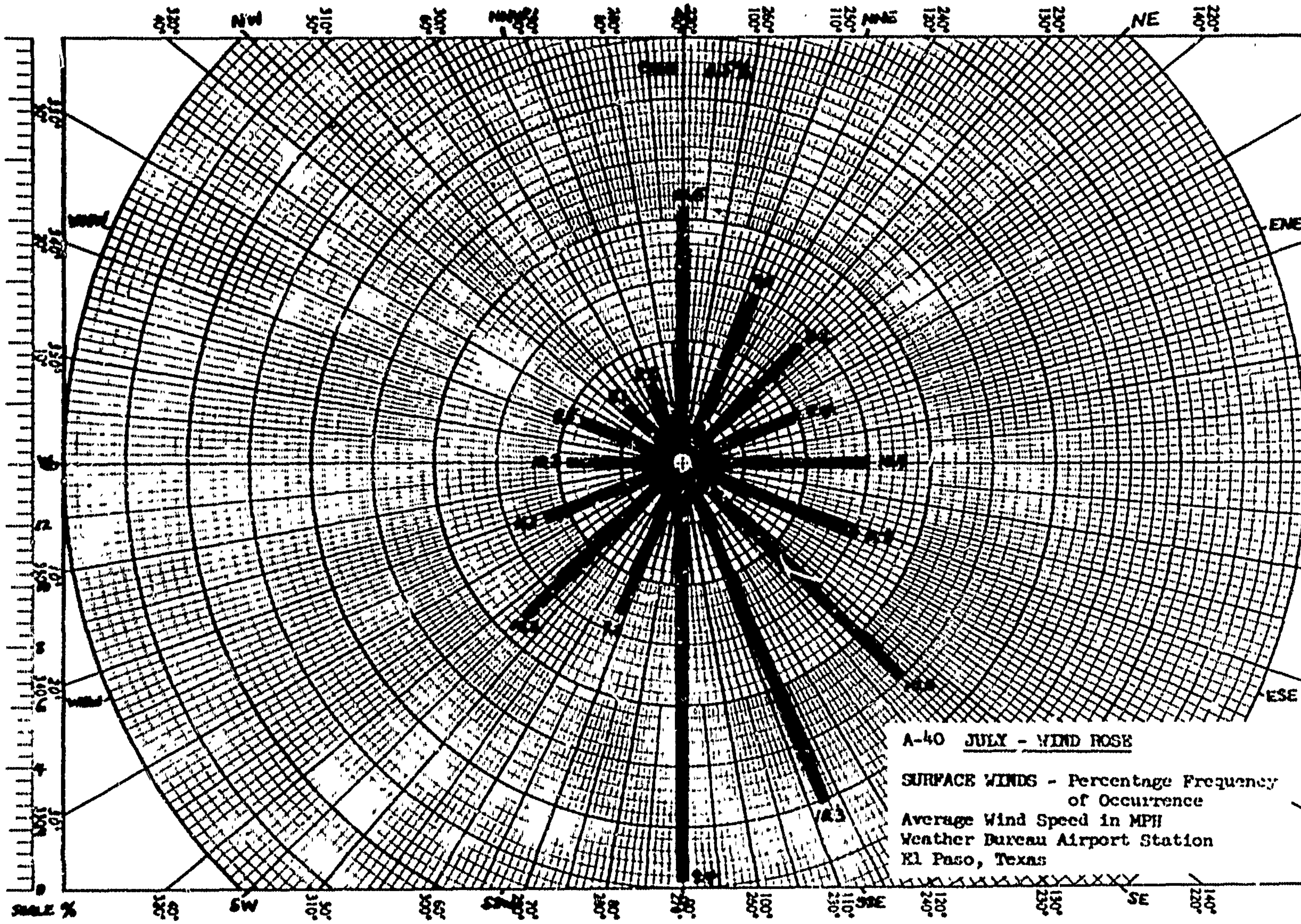
Weather Bureau Airport Station

El Paso, Texas



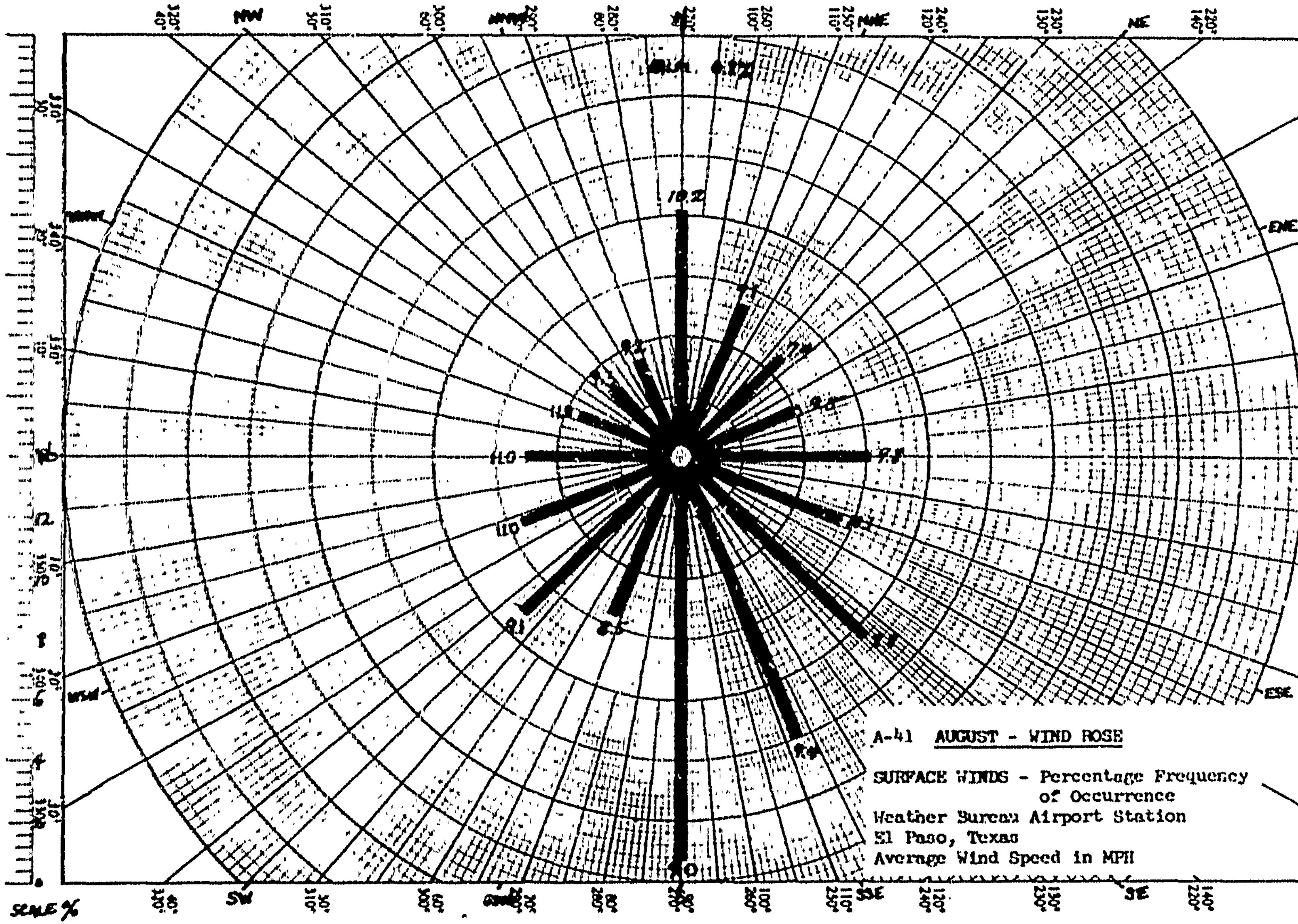
A-59 JUNE - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed In MPH
Weather Bureau Airport Station
El Paso, Texas



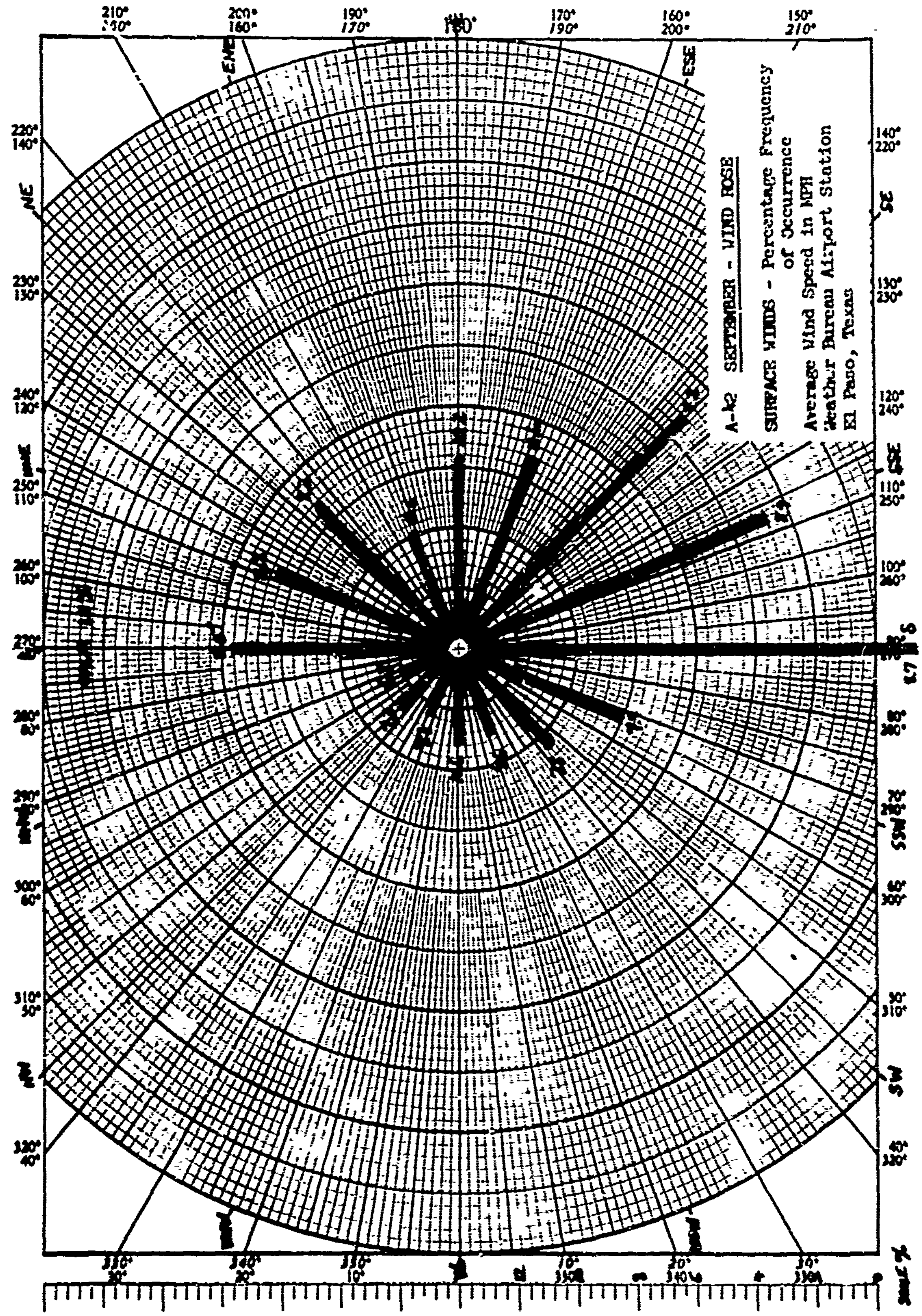
A-40 JULY - WIND ROSE

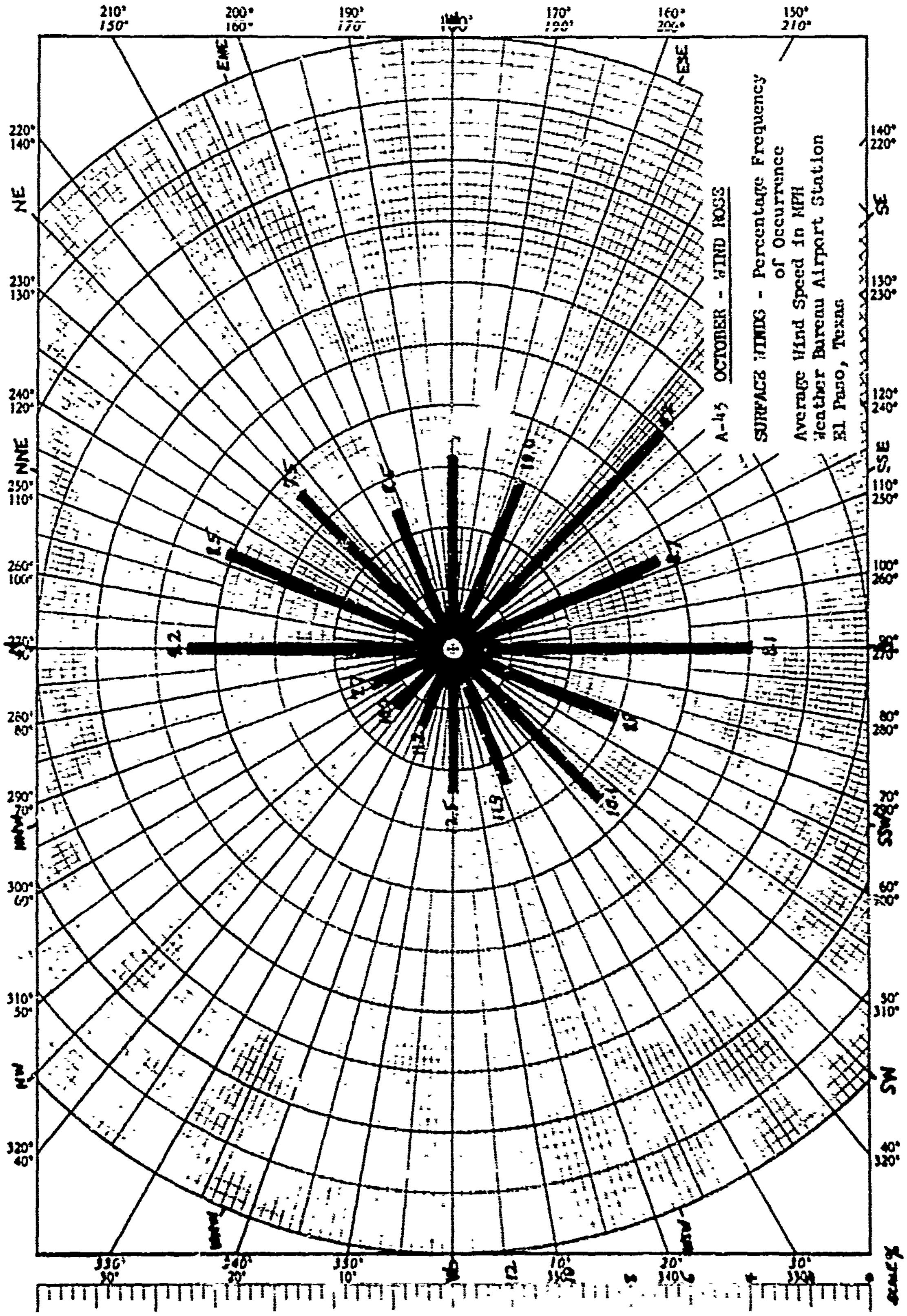
SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas

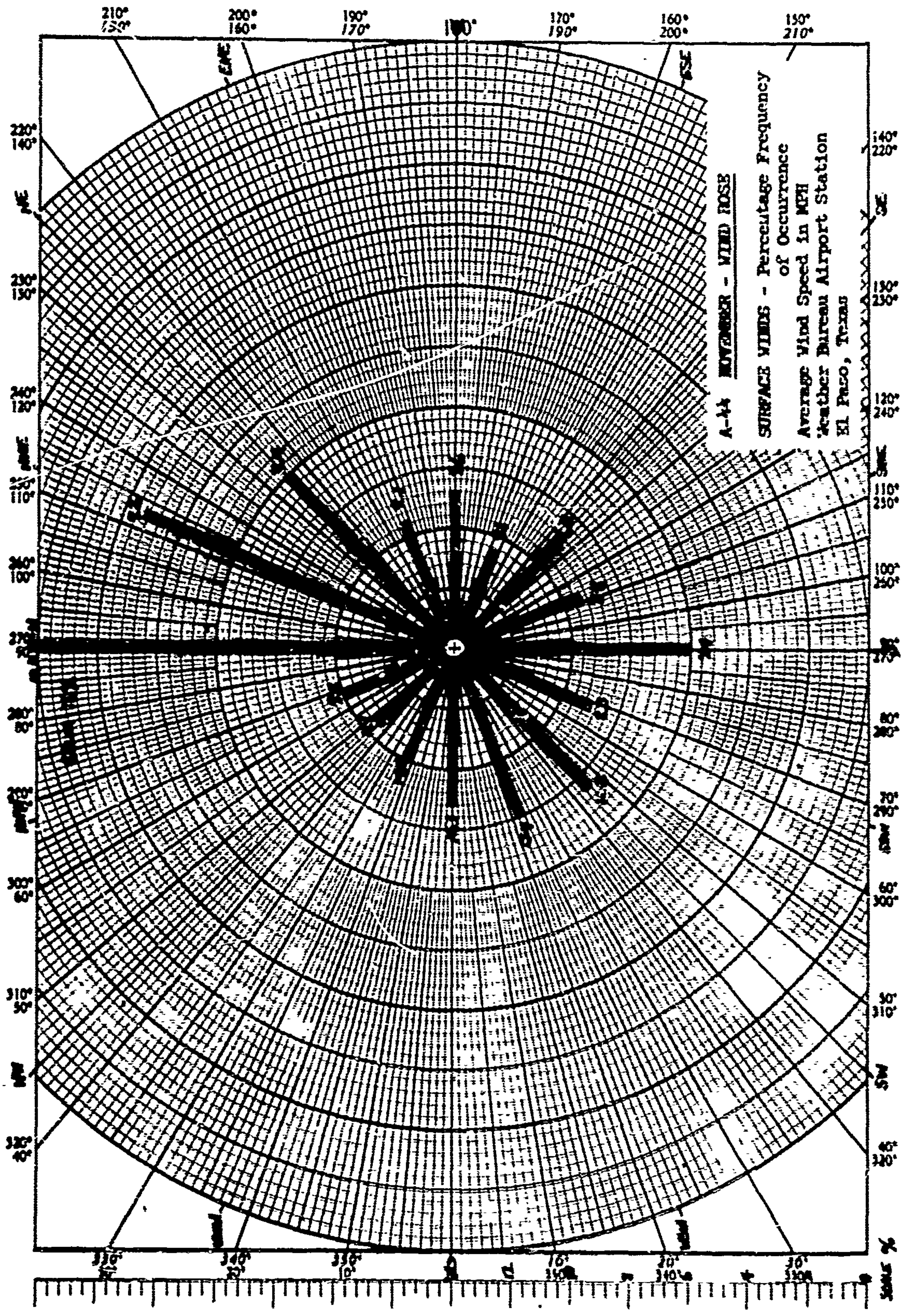


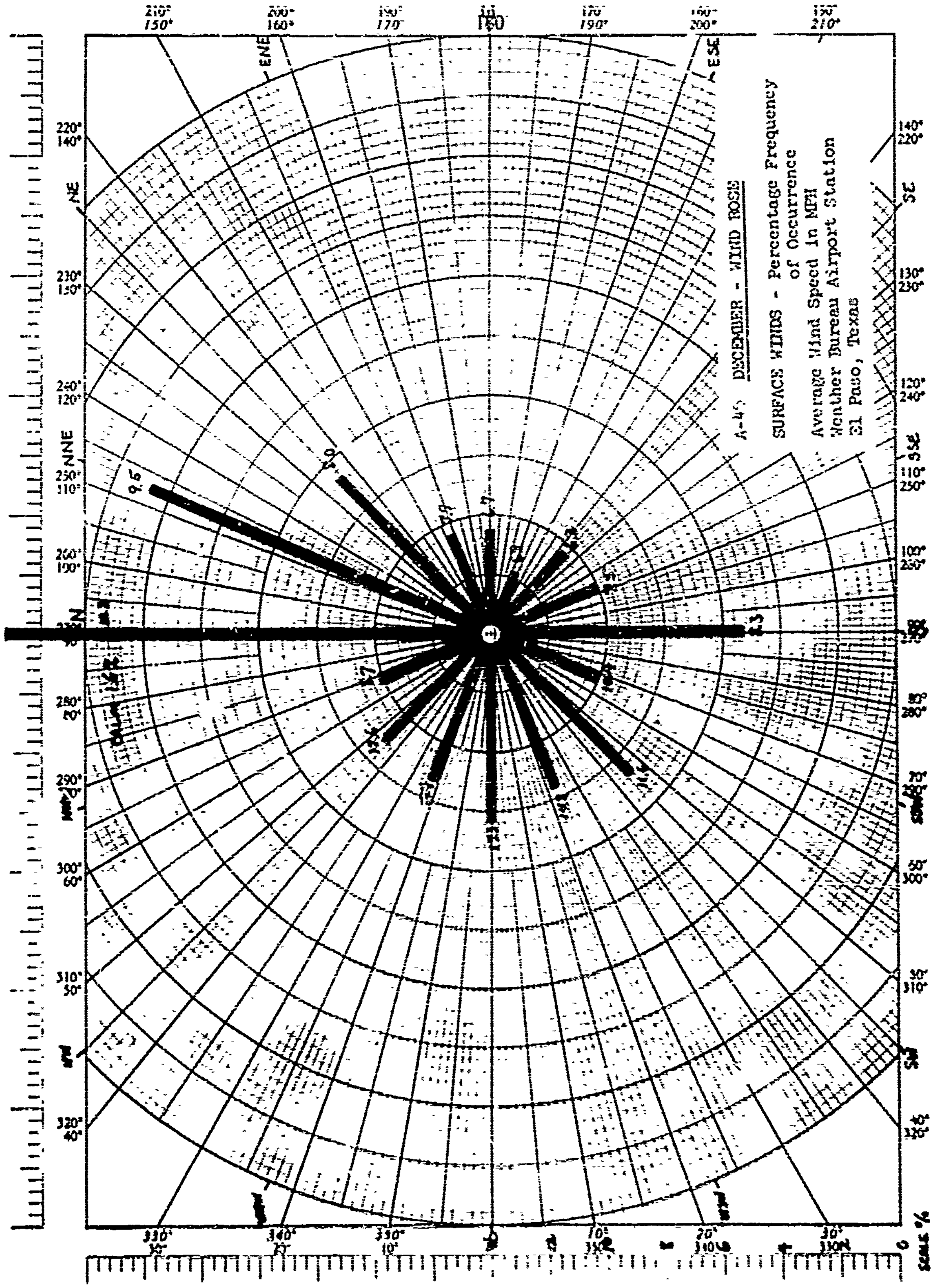
A-41 AUGUST - WIND ROSE

SURFACE WINDS - Percentage Frequency of Occurrence
Weather Bureau Airport Station
El Paso, Texas
Average Wind Speed in MPH

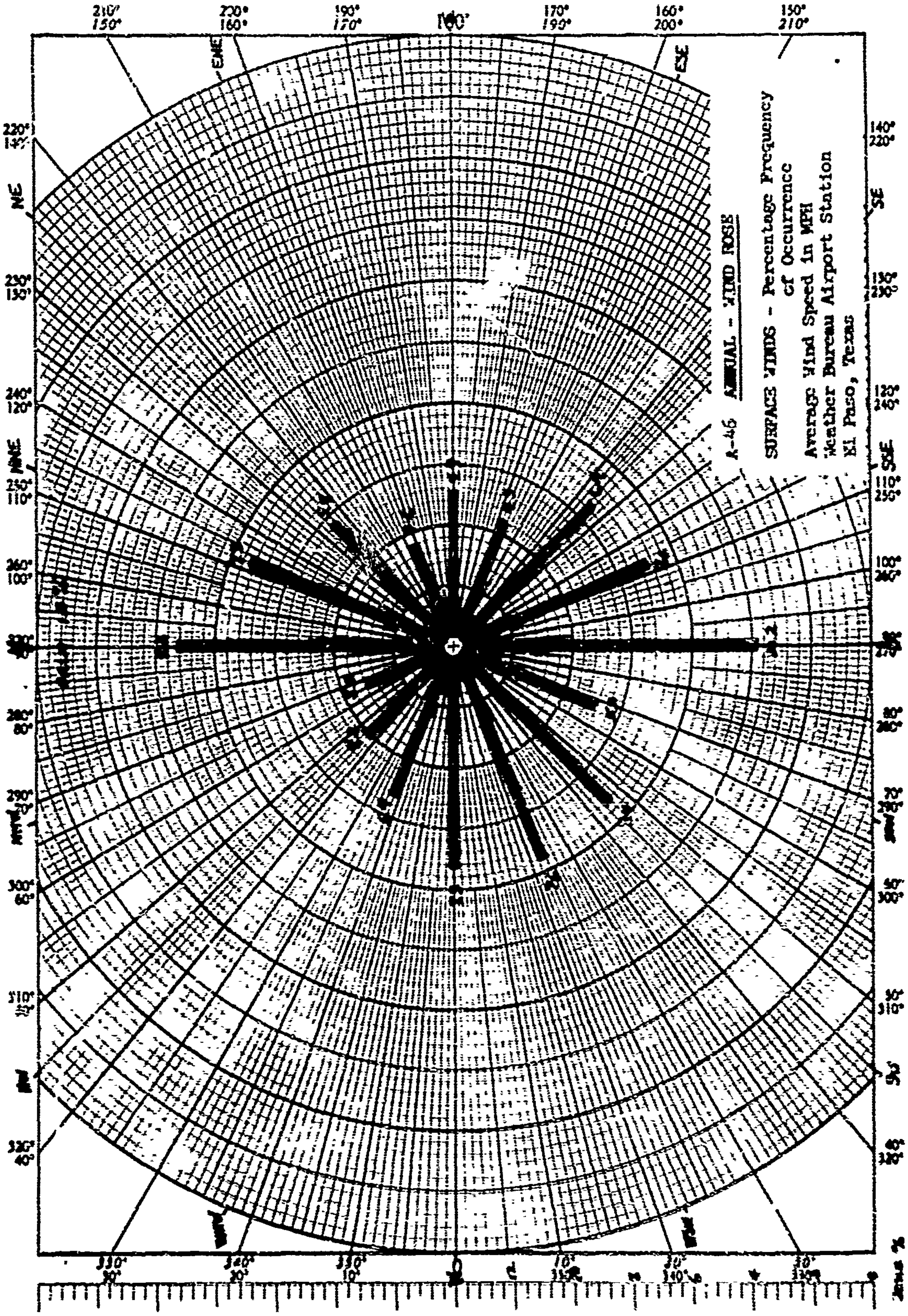

A-42 SEPTEMBER - WIND ROSE
SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas


A-45 OCTOBER - WIND ROSE
SURFACE WINDS - Percentage Frequency
of Occurrence
Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas


A-44 NOVEMBER - WIND ROSE
SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed in MPH
Weather Bureau Airport Station
El Paso, Texas



A-45 DECEMBER - WIND ROSE
SURFACE WINDS - Percentage Frequency of Occurrence
Average Wind Speed In MPH
Weather Bureau Airport Station
El Paso, Texas
NE
NNE
N
ENE
ESE
SE
SSE
9.6
5.0
8.3
SCALE %



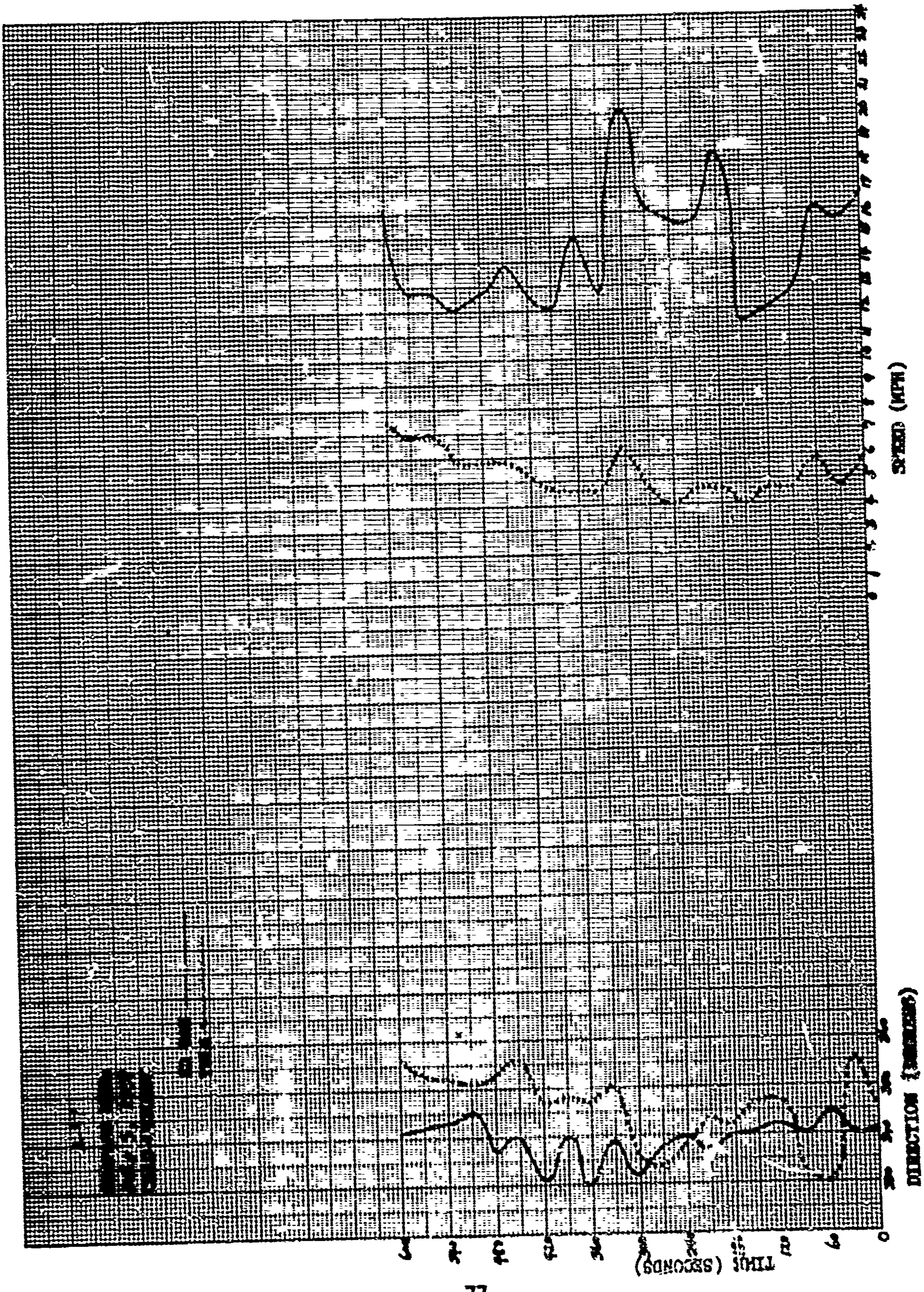
A-46 ANNUAL - WIND ROSE

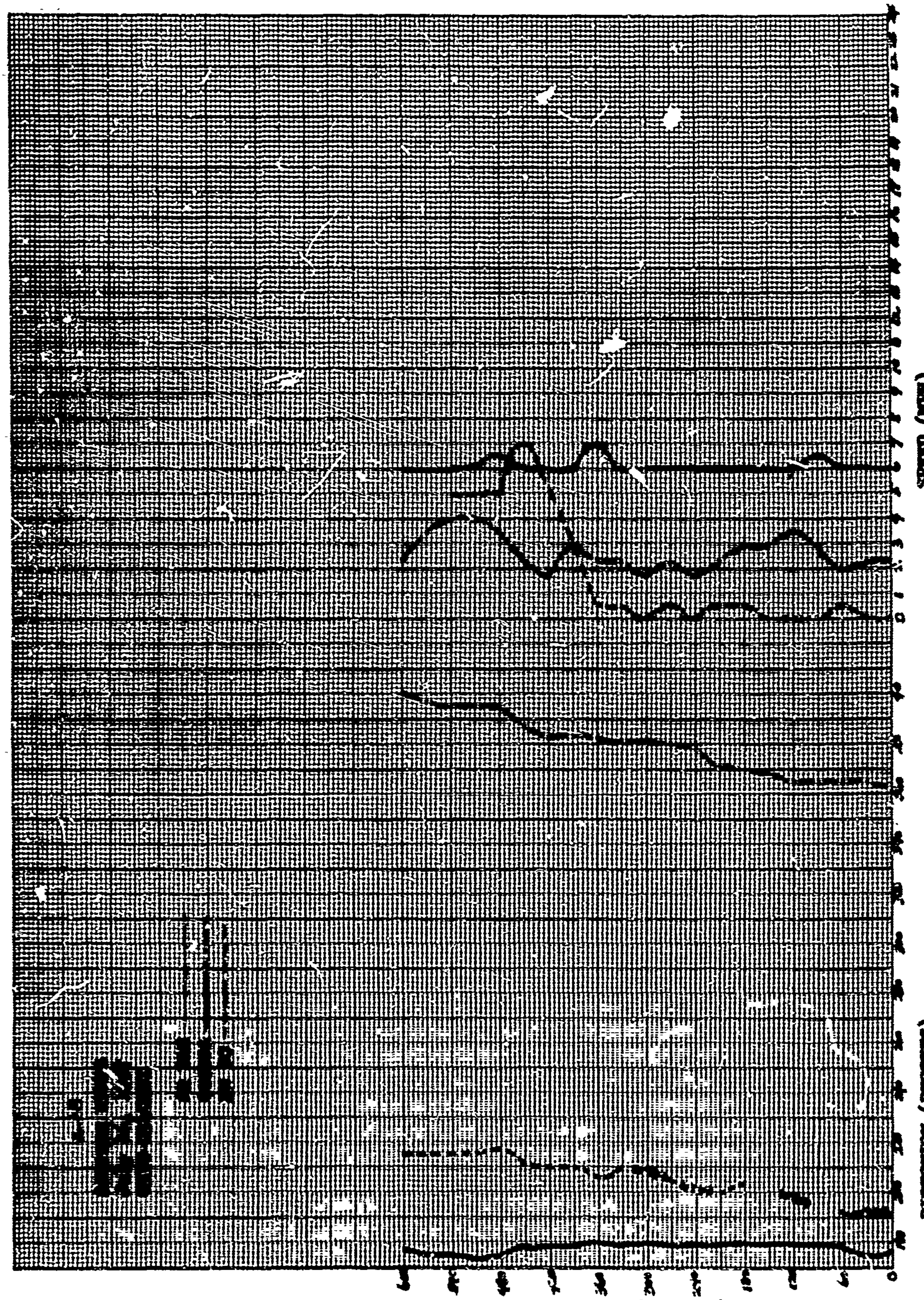
SURFACE WINDS - Percentage Frequency of Occurrence

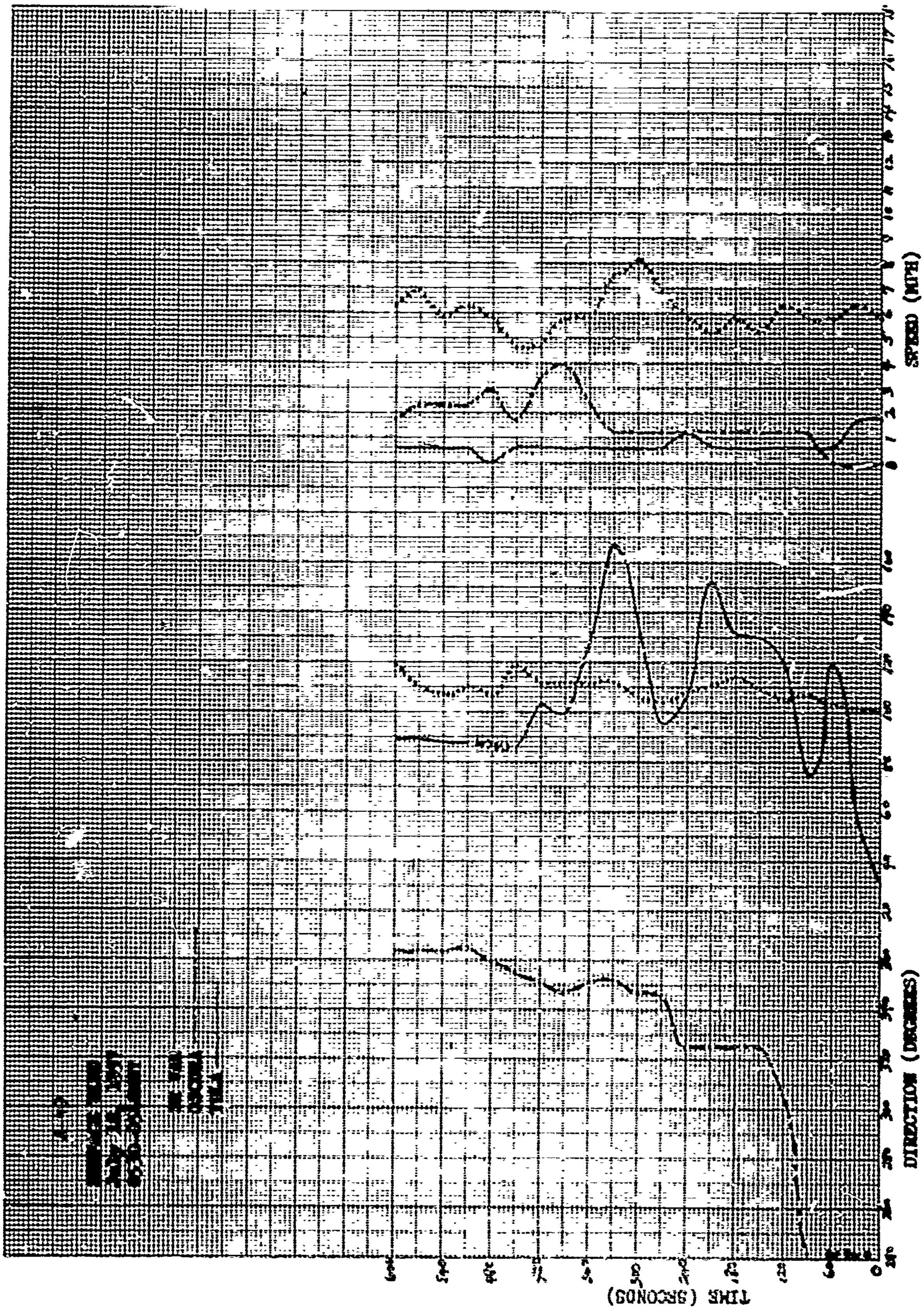
Average Wind Speed in MPH

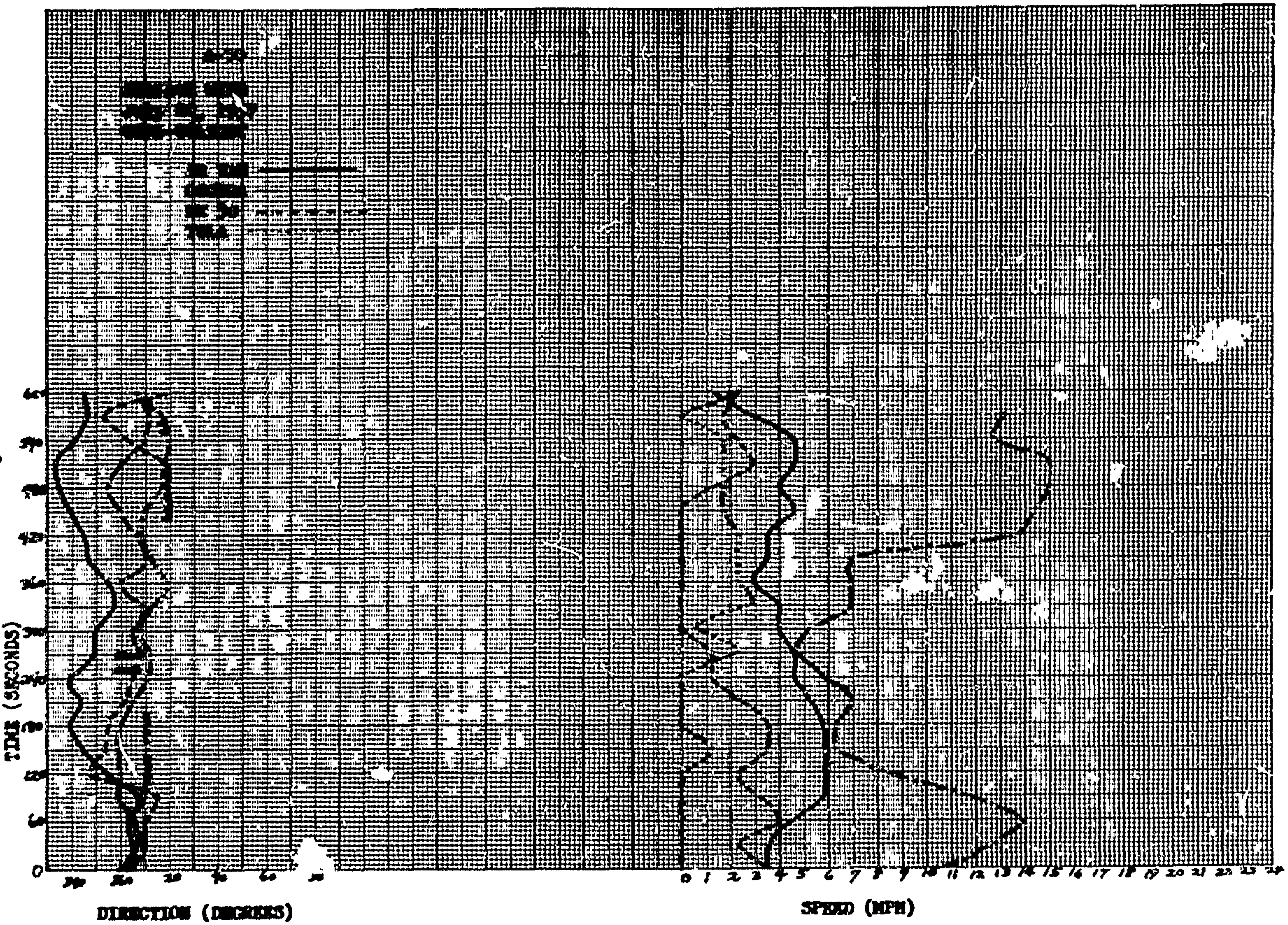
Weather Bureau Airport Station

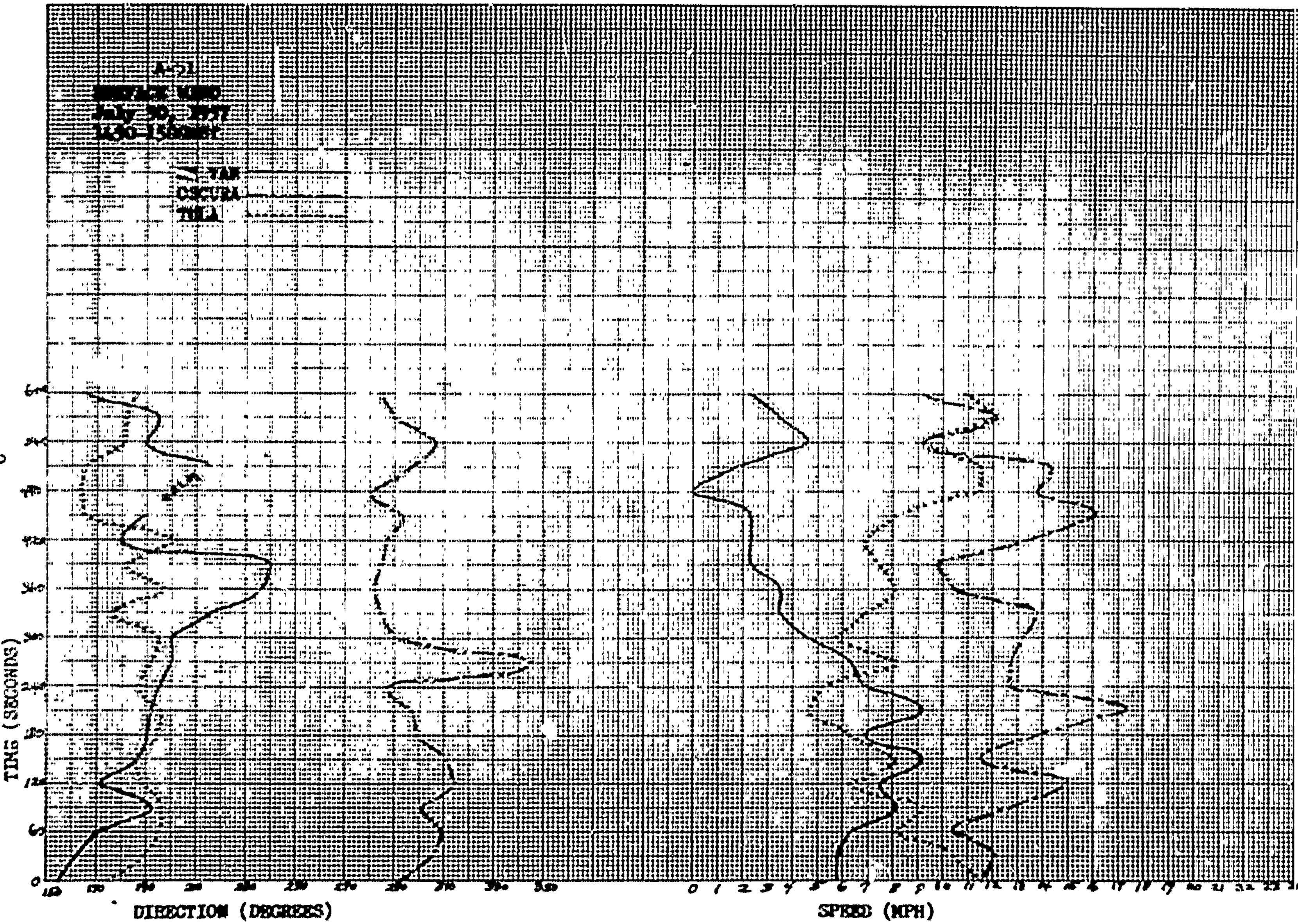
El Paso, Texas

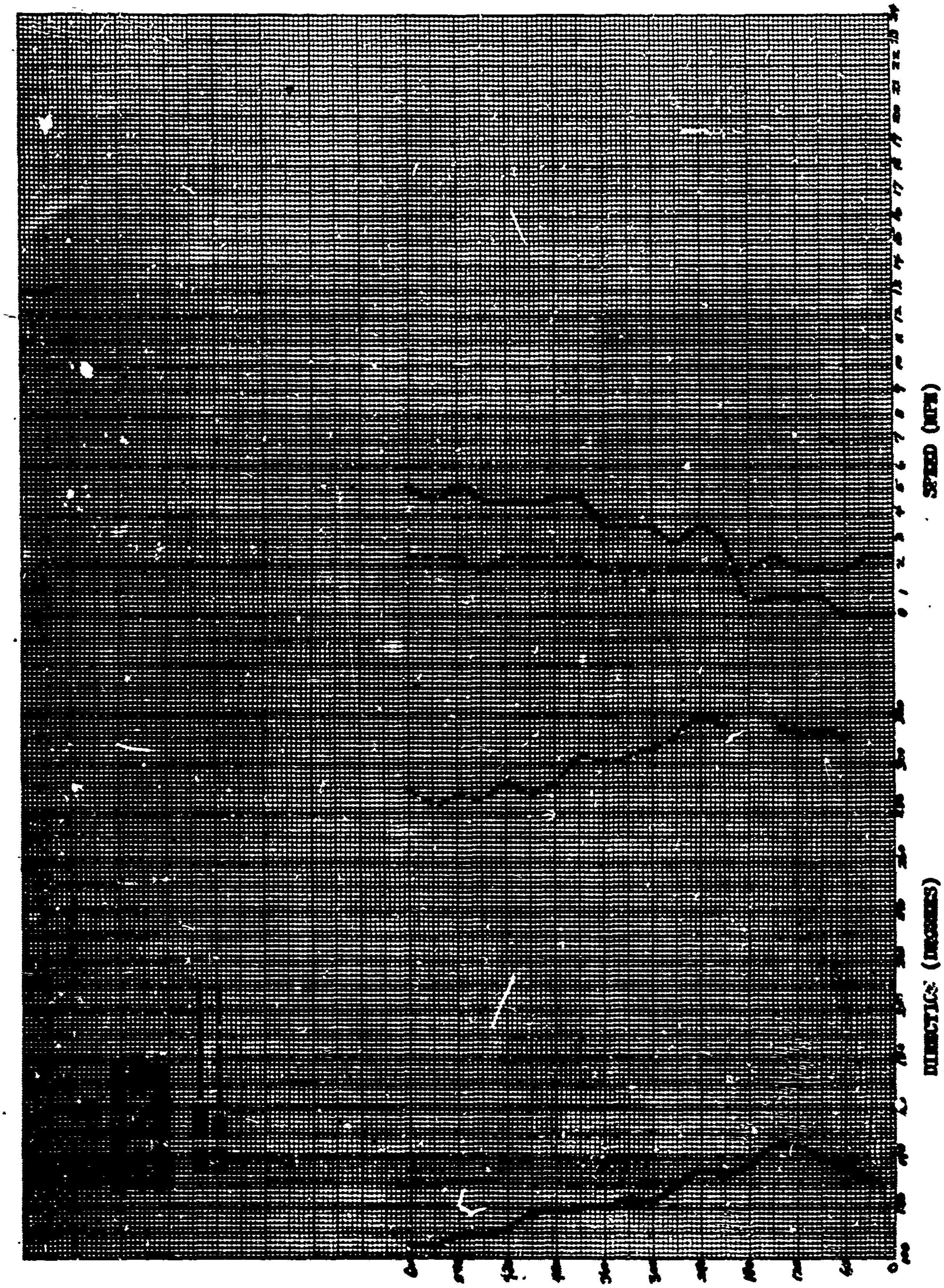

SPEED (MPH)
DIRECTION
TIME (SECONDS)


SPEED (MPH)
DIRECTION (DEGREES)
TIME (SECONDS)


SPEED (MPH)
DIRECTION (DEGREES)
TIME (SECONDS)


TIME (SECONDS)
DIRECTION (DEGREES)
SPEED (MPH)


A-21
VAN
OSCURA
TULA
TIME (SECONDS)
DIRECTION (DEGREES)
SPEED (MPH)


SPEED (MPH)
DIRECTION (DEGREES)
TIME (SECONDS)